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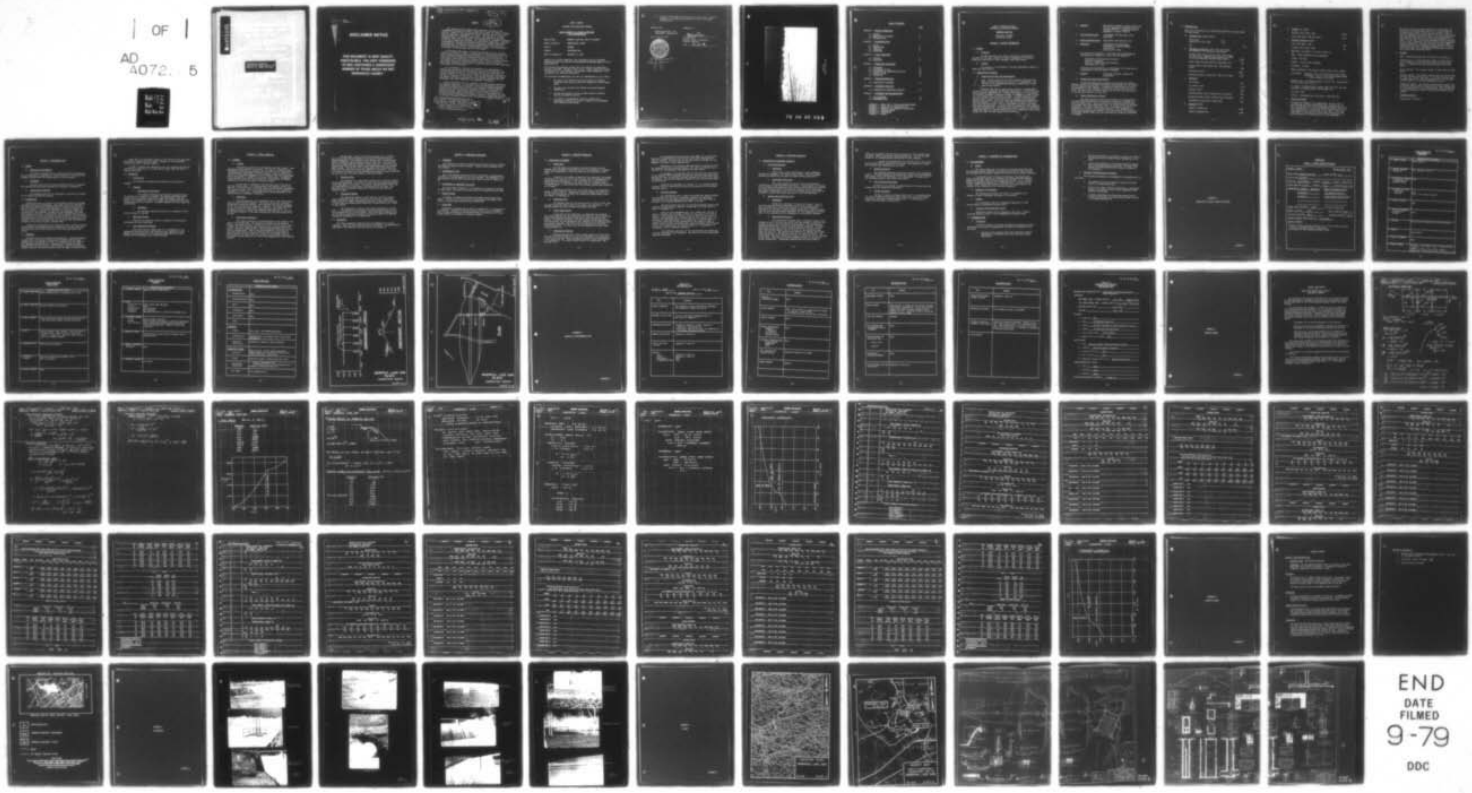

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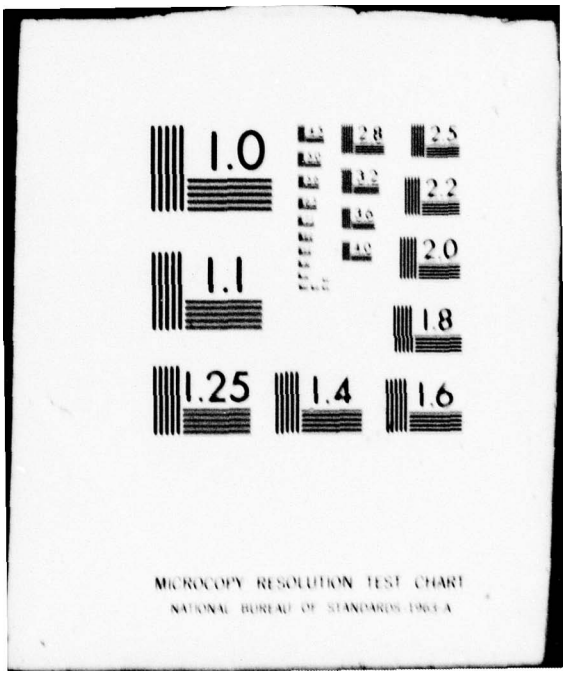
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(15) DACW31-79-C-0012 (11) May 79

(12) 81p.

PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evoluntionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

(6) National Dam Inspection Program.
Memorial Lake DAm (NDI Number PA-00603, DER Number 38-80), Susquehanna River [redacted] Basin, Lebanon County, Pennsylvania.
Phase I Inspection Report.

411 003 Gm

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS AND RECOMMENDATIONS

Name of Dam:	MEMORIAL LAKE DAM, NDI NO. PA-00603
State & State No.	PENNSYLVANIA, 38-80
County:	LEBANON
Stream:	INDIANTOWN RUN
Date of Inspection:	November 11, 1978

Based on the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in good condition.

The spillway and available storage have the capacity for passing 47 percent of the PMF. Because the dam is not a "High" hazard and because 1/2 PMF will not cause failure, the spillway, while inadequate, is not considered to be seriously inadequate.

The following recommendations are made for implementation by the owner:

1. The stem on the drawdown sluice gate should be repaired immediately and this gate should be operated on a semi-annual basis.

2. The end of the spillway slab should be protected against undermining.

3. The wet area adjacent to the spillway should be properly drained and closely observed.

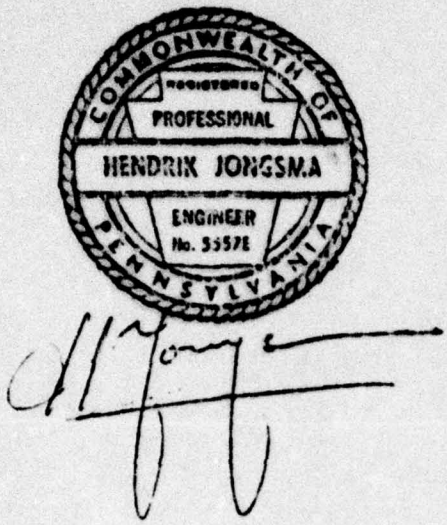
4. The brush on the embankment should be removed and a maintenance schedule for control of weeds on the embankment slope should be established.

5. A formal surveillance and downstream warning system should be developed to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

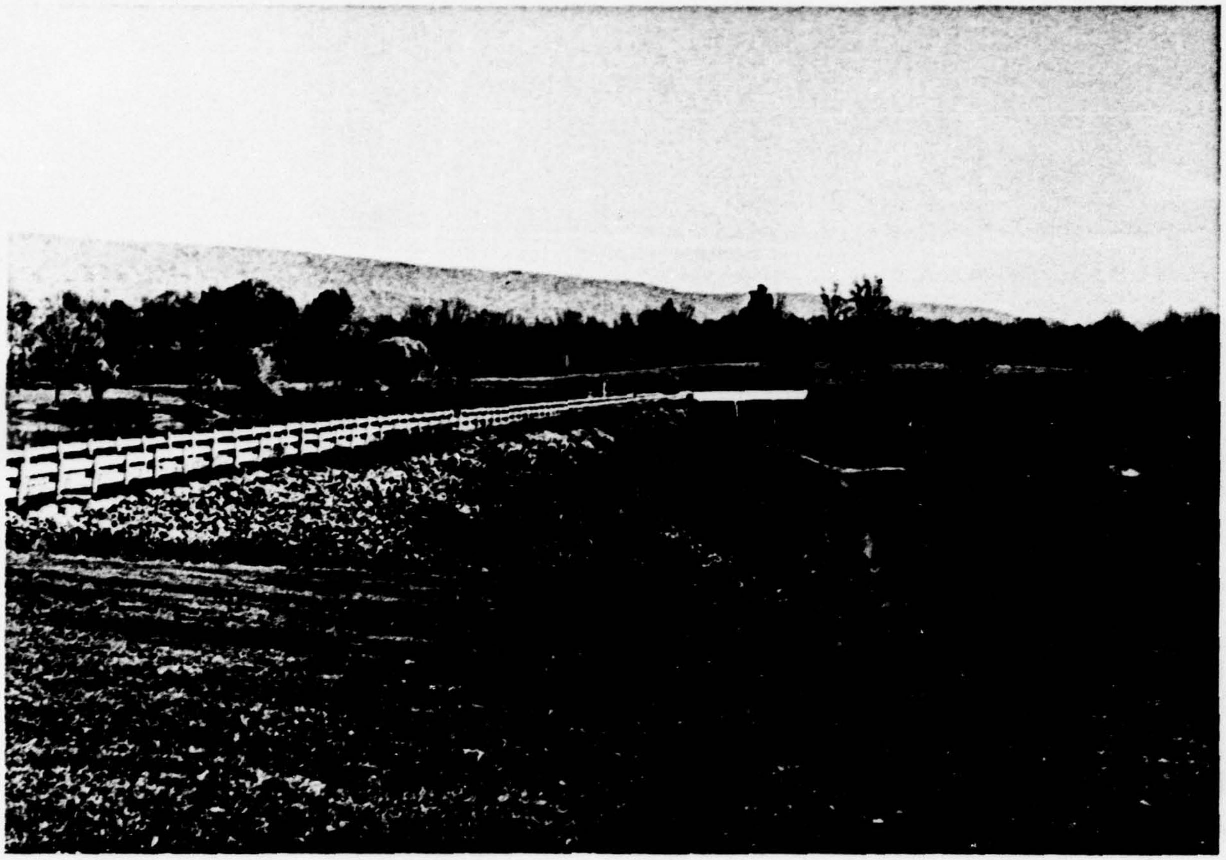
DATE: May 29, 1979



APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE 27 Jun 79



OVERVIEW
MEMORIAL LAKE DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MEMORIAL LAKE DAM

NDI-ID NO. PA-00603
DER-ID NO. 38-80

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

ABSTRACT

Note: Project datum for this dam is 305 feet less than the mean sea level datum shown on the U.S.G.S. Quadrangle. Add 305 feet to all engineering drawings to obtain M.S.L. datum used in this report.

Memorial Lake Dam was constructed in 1945 as a recreational facility for the Indiantown Gap Military Reservation. The 760 foot long rolled earthfill embankment has a maximum fill height of 37 feet above the original streambed. Reference is made to Appendix F, Plates III and IV, for a general plan and typical section. A cutoff trench was excavated along the centerline of the dam and a concrete cutoff wall was placed in this trench. A 110 foot long ogee spillway was excavated in the left abutment. It has a weir crest elevation of 430.0, which is 8 feet below the top of dam. The ogee discharges the water to an eight foot deep stilling basin. A control tower is located 12.5 feet upstream from the centerline dam. Flow through the 48-inch conduit is controlled inside the tower by a 48-inch sluice gate or by a gated weir also located inside the tower and near normal pool elevation.

ABSTRACT

B. Location: East Hanover Township, Lebanon County, PA
U.S.G.S. Quadrangle, Indiantown Gap, PA
Latitude 40°-25.1', Longitude 76°-35.4'
(Appendix F, Plates I and II)

C. Size Classification: Intermediate (37 feet high, 2,575 acre-feet)

D. Hazard Classification: Significant (See Section 3.1.E)

E. Ownership: Commonwealth of Pennsylvania
Department of Military Affairs
Armory Board
Annville, PA 17003

The control and maintenance of the lake and surroundings are relinquished to PennDER as a State Park and belong to:

Department of Environmental Resources
Bureau of Operations
Room 213, Evangelical Press Building
Harrisburg, PA 17120

Ownership and responsibility of maintenance of the dam will be transferred in the near future to PennDER.

F. Purpose: Recreation (fishing, boating and picnicking).

G. Design and Construction History

The dam and appurtenant structures were designed by Gannett, Fleming, Corddry and Carpenter, Harrisburg, Pennsylvania, for the Department of Properties and Supplies. A permit for construction was issued on September 12, 1945, although construction started prior to June 27, 1945. The name of the contractor was not in the files and construction of the dam was completed in June, 1946.

H. Normal Operating Procedures

The lake, boat dock and picnic facilities are relinquished to the Pennsylvania Department of Environmental Resources (PennDER) and used as a public park. These facilities are maintained and supervised by PennDER, and a park maintenance office is located within the Military Reservation. The weir, inside the tower, is frequently operated to maintain a pool level at the desired elevation. The embankment and appurtenant structures are, however, still maintained by the Department of Military Affairs (DMA) until the facilities are formally transferred to PennDER.

1.3 PERTINENT DATA

Note: All elevations are to USGS datum (add 305 to project datum for USGS datum).

A. Drainage Area (square miles)

From files	-	7.5
Computed for this report		7.87
Use		7.9

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations

Maximum known flood, June 22, 1972, from records for the U.S.G.S. gaging station which is located 2.0 miles downstream from dam (peak inflow)	3,300
Outlet works low pool outlet at pool Elev. 407	150
Outlet works at pool level Elev. 430 (spillway crest)	380
Warm water outlet	None
Spillway capacity at pool Elev. 438 (top of dam)	7,300

C. Elevation

Top of dam	438
Low point in dam	437.7
Spillway crest	430
Upstream portal invert (48-inch cast iron pipe)	402
Downstream portal invert (48-inch cast iron pipe)	401
Streambed at centerline of dam, about	401

D. Reservoir (feet)

Length of normal pool	4,000
Length of maximum pool	4,300

E. Storage (acre-feet)

Spillway crest (Elev. 430)	1,680
Top of dam (Elev. 438) from HEC-1	2,575

F. Reservoir Surface (acres)

Top of dam (Elev. 438)	139
Spillway crest (Elev. 430)	87

G. Dam (Refer to Appendix F, Plates III and IV)

Type: Rolled impervious fill embankment.

Length: 760 feet.

Height: 37 feet above streambed.

Top Width: 15 feet.

Breast Elevation: 133 (project datum); 438 (U.S.G.S. datum)

Side Slopes: Upstream - 2H to 1V with 18-inch stone facing.
Downstream - 2H to 1V with stone facing varying from 12 inches to 18 inches.

Cutoff Trench: On centerline dam to top of rock. Bottom width 20 feet, side slopes 1H to 1V.

Core Wall: On centerline of trench, three feet into rock and extending to varying heights (see Section 2.2).

Grouting: None.

Filters: Downstream stone toe drain to elevation 410.

H. Outlet Facilities

A reinforced concrete, three-compartment, control tower is located about ten feet upstream from the centerline of the dam. The larger of the three compartments receives water from the reservoir via a 47 foot long, 48-inch diameter cast iron pipe controlled by a 48-inch gate in the tower. This tower compartment is drained by a 87 foot long, 48-inch cast iron pipe extending to the downstream toe of the embankment.

The control tower also makes provision for maintaining the lake level by spilling bottom water over a weir instead of allowing surface water to pass over the spillway. This is done by inserting a 24-inch by 48-inch tee in the 48-inch pipe just upstream from the control tower. The uncontrolled 24-inch pipe runs from the tee to the second compartment in the tower. At the top of the second compartment, water flows over a 4-foot wide, adjustable weir plate into a third compartment which is drained by a low-level 6-inch by 24-inch opening leading into the first compartment mentioned above. The top of the weir plate can be adjusted between project elevation 123.5 and project elevation 126.25.

I. Spillway

Type: Uncontrolled ogee weir (see Plate III, Appendix C).

Length of weir: A total effective length of about 107 feet. It is divided into three bays by two 17-inch wide bridge piers. In addition, the two outer walls have a 1H to 12V batter.

Crest elevation: 125.0 project datum, or 430.0 mean sea level datum.

Upstream channel: The channel upstream from the weir is about 120 feet wide and 100 feet long. It is about four feet deep at normal pool level. With the exception of a 25-foot wide concrete apron, it is unlined excavation in rock.

Downstream channel: The concrete ogee descends directly into a 104-foot wide by 120-foot long by 8-foot deep stilling pool. At the downstream end of the stilling pool, water spills over a concrete slab and a two-foot drop into the natural stream channel.

J. Regulating Outlets

See Section 1.3.H above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of PennDER did not contain any design calculations for the hydrology or hydraulics for these faciliites. A check with the designer revealed that the design analysis is not available.

B. Embankment

The data search did not find any design criteria or analyses. The existing data and design drawings are presented in Appendix F.

C. Appurtenant Structures

The available data for the appurtenant structures are limited to the design construction drawings.

2.2 CONSTRUCTION

Construction data is limited to a few progress reports by PennDER and some construction photographs. The cutoff trench was excavated to hard shale and inspected by PennDER before the concrete of the wall footer was poured. The drawings (Appendix F, Plate IV) indicate that the core wall was to extend to 2 feet above the original ground, but because of the poor material available for the embankment, the plans were changed as follows: "from Station 0+80 to Station 5+00 the top of the wall will be at Elevation 109.0, at Station 6+00 the top of the wall elevation will be 113.4, at Station 7+00 the top of the wall will be at Elevation 126.5, and at Station 7+51 the top of the wall elevation will be 132.5 to the end of the dam at Station 7+83".

Construction photographs and an inspection report indicate that the bridge across the spillway was under construction in April, 1946, and that the piers were erected before the top of the ogee section was placed.

2.3 OPERATION

No formal records of operation are maintained. Inspection reports indicate that a few inches of settlement occurred around the right seepage fin of the spillway in 1950. This probably was the result of poor compaction around the fin. Seepage at the toe near the right spillway wall was noticed and is still present. Other wet areas were present along the toe, mostly caused by poor drainage in this flat area.

Since 1963, the stem guide brackets on the 48-inch sluice gate have been loose, causing the stem to bend. The gate is of the unseating pressure type and is leaking slightly.

In 1969, a weephole was installed in the left spillway wall and the lake has been drawn down 3 or 4 feet several times (1963 and 1964) to install boat docks.

2.4 EVALUATION

A. Availability

The available information was obtained from the files at PennDER.

B. Adequacy

1. Hydrology and Hydraulics

The available hydrologic and hydraulic information was not sufficient to evaluate the design. The permit application report stated that the spillway capacity was 9,960 cfs; however, this was before it was decided to construct a bridge, which restricted the clear opening and acted as an orifice. No permit approval for this bridge was in the files.

2. Embankment

The available engineering data are not adequate to evaluate the design of the dam.

C. Operating Records

There are no operating records to evaluate the operational performance of these facilities.

D. Post Construction Changes

There have been no changes made to the embankment or the appurtenant structures since the facilities were completed in 1946. However, the construction of the vehicular bridge across the ogee section was not included in the design drawings.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Memorial Lake Dam is good. Some maintenance work, however, is required. This lake is located in Fort Indiantown Gap Military Reservation which is owned by the Commonwealth of Pennsylvania, Department of Military Affairs. Most of the area is leased to the Federal Government, but the Memorial Lake and surroundings were relinquished to PennDER to be used as a State Park. Although no formal transfer took place, the park itself is maintained by PennDER. Ownership is still in the hands of Military Affairs.

At the time of inspection, the pool level was at the top of the weir (normal pool). Mr. Robert Holden, Park Foreman, and Mr. Ron Hamilton, a representative of PennDER, Bureau of Operations, accompanied the inspection team. The visual inspection check list is contained in Appendix A of this report. Photographs taken during inspection of the installation are reproduced in Section E.

B. Embankment

The upstream slope of the embankment has a loose stone facing with some weeds and brush growth. The top of the dam has a blacktop paving and a pedestrian railing. The horizontal and vertical alignment of the crest were good (see Appendix A, sketch). The downstream slope is also covered with loose stone, some weeds and small brush. No sloughing, erosion or unusual toe movements were detected. A wet area was observed adjacent to the right spillway wall just beyond the toe of the dam.

C. Appurtenant Structures

The control structure is located adjacent to the breast of the dam at the upstream side. The operator's platform has two operator stands. One stand operates a control weir (4'-0" x 3'-0") at the top of a baffle wall which controls pool levels between elevations 123.5 and 126.25. The other stand operates a 48-inch unseated sluice gate on the 48-inch drawdown pipe. Some of the guide brackets for the stem have been torn loose from the concrete and the stem is seriously bent at several places. The gate cannot be operated in the present condition. The conduit outlet structure has fairly long wingwalls and a well defined channel.

The spillway, located in the left abutment, has a concrete ogee section with concrete abutment walls and a stilling basin for energy dissipation. The approach to the spillway weir is unobstructed and well channeled with an approach depth of four feet. The weir and walls are in good condition except for some spalling. The joint at the abutment wall and weir show signs of some deterioration due to constant water erosion. The walls in the stilling basin have some cracks, but these will not affect the structural integrity of the walls. The slab at the end of the basin has been undermined and requires riprap protection. Two piers on top of the weir support a vehicular bridge.

D. Reservoir Area

The reservoir is a State Park facility and is used for fishing, boating and picnicking. All banks are flat, have well maintained grass slopes and appear to be stable. The owner's representatives stated that some sedimentation is occurring in the upper part of the lake. The watershed area is generally wooded with a small upstream reservoir (Marquette Lake).

E. Downstream Channel

The downstream channel is wide and flat, until the stream passes underneath a park road through two pipe arches. Beyond this road, the area is lightly forested and flat for a length of 1,700 feet, at which point the stream passes underneath Interstate Route 81 through an arch culvert.

The interstate is wide and well above the height of a flood-wave. It is expected that no further downstream damage would occur if the dam would fail due to overtopping. Due to the high economical loss to this heavily used public facility, the hazard category for Memorial Lake Dam is considered to be "Significant".

3.2 EVALUATION

The visual inspection indicates that the embankment is in good condition. Weed and brush growth should be controlled. The non-operative condition of the drawdown sluice gate should be attended to.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

This reservoir is used for recreation and the pool level is normally maintained at spillway crest elevation. Excess inflow discharges over the spillway.

4.2 MAINTENANCE OF DAM

Due to the present transition period in ownership, the maintenance procedures of the embankment are not well defined. The embankment is in good condition except that weed and brush control should be taken care of.

4.3 MAINTENANCE OF OPERATING FACILITIES

The non-operable condition of the drawdown sluice gate has existed for many years. The owners have been aware of the condition since 1963.

4.4 WARNING SYSTEM

At present, no formal surveillance and downstream warning system exists. Records of pool levels are not maintained, even though a park office is located about one mile away from the dam.

4.5 EVALUATION

Maintenance procedures do not exist at present due to the transition of ownership. Although the hazard category is low, is is recommended that a formal surveillance and warning system be established to be used during periods of prolonged or intensive rainfall.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from the PennDER files for Memorial Lake Dam were not very extensive. Frequency curve, unit hydrograph, or flood routings were not available in the files.

A review of the design, prepared by the predecessor to PennDER, indicates a "C" value of 4.0 for the spillway, and a corresponding top-of-dam discharge of 9,960 cfs. This was stated to be 1,420 cfs per square mile or 3,750 divided by the square root of a drainage area of 7.0 square miles. It was stated that the spillway capacity was considered to be "ample".

Computations prepared for this report give a top-of-dam discharge of only 7,300 cfs. Apparently, the above figure of 9,960 cfs is for the same spillway but without the bridge and bridge-support piers (see Sheet 1 of Appendix C).

B. Experience Data

The maximum flood for this dam was that of June 22, 1972, when the peak inflow was about 3,300 cfs (see Sheet 2 of Appendix C). The spillway passed that flood without any signs of distress.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped. It should be noted that the most serious problem noted during this inspection, was the apparently poor condition of the Marquette Lake Dam one mile upstream. That dam is 33 feet high and the lake holds 20,000,000 gallons. The dam is old and the embankment has many large trees growing on it.

D. Overtopping Potential

Memorial Lake Dam has a total storage capacity of 2,575 acre-feet and an overall height of 37 feet above streambed, both referenced to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "Significant" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is one-half of the Probable Maximum Flood (PMF) to the PMF. For this dam, the PMF peak inflow is 18,500 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 18,500 cfs with the estimated spillway discharge capacity of 7,300 cfs indicates that a potential for overtopping of the Memorial Lake Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 46% of a PMF.

Improving the embankment by raising it to its intended design elevation will not significantly increase the capacity of the spillway-reservoir system.

E. Spillway Adequacy

The intermediate size category and significant hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be one-half of the Probable Maximum Flood (PMF) to the PMF.

The calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 46% of the PMF (Refer to Sheet 8 of Appendix C).

Being an earth embankment dam, it is judged that a breach is likely to develop when the depth of flow over the crest is 0.5 foot or greater. These studies also indicate that the depth of flow over the crest of the embankment due to one-half PMF is less than 0.5 foot. On the basis of this information, it is judged that a one-half PMF will cause some overtopping of the embankment but not enough to cause a breach. Based on this information and because the hazard classification of the dam is significant, the spillway capacity is considered to be inadequate, but not seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

There were no visual indications of undue embankment stresses or sloughage. The slopes appear stable. The only seepage detected was beyond the toe near the right stilling basin wall.

2. Appurtenant Structures

The visual inspection did not detect any structural instabilities of the appurtenant structures. A small amount of cracking of the stilling basin walls and some concrete deterioration has occurred, but these will not effect the structural integrity of the structures. The further undermining of the end of the stilling basin slab should be prevented to insure the future efficiency of the stilling basin.

B. Design and Construction Data

1. Embankment

Design data could not be located for review. The construction drawings show an embankment section with adequate slopes, a rock toe drain and a cutoff wall anchored in the rock foundation. Records do not indicate a serious seepage problem and it can be assumed that the fill was sufficiently impervious for this homogeneous earthfill dam. It is considered that the embankment is structurally adequate.

2. Appurtenant Structures

The construction drawings show a reinforced control tower founded on rock. The cast iron outlet pipe was encased in concrete, but seepage collars are not indicated on the drawings. The concrete ogee section was keyed into the rock and sufficiently reinforced. The abutment walls and the walls of the stilling basin are shown as one foot thick walls poured against rock in the rock cut and as gravity walls above the rock cut. The gravity walls appear to be adequate with dimensions of one foot on the top and a base of .45 times the height. The walls against the rock, placed with a slope of 1H to 12V, are not anchored to the rock. There are no as-built drawings available to review the actual construction. Photographs indicate that the shale broke up

easily and it appears that very little vertical cut was obtained along the walls. Shale is an easily weathering material. The lack of rock anchors is not considered good construction at this location.

Beyond the stilling basin is a 28 feet long, 8-inch thick concrete slab with no cutoff wall at the end. The absence of a cutoff has permitted some undermining of the slab.

C. Operating Records

The available operating records are limited to some inspection reports. The main problem is the non-operable condition of the drawdown sluice gate, due to the loosening of two stem guides. The gate is of the unseating pressure type, which often leaks.

D. Post Construction Changes

Records do not indicate any modifications to the dam since the construction was completed in June 1946.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available design data and the operating history indicates that Memorial Lake Dam has been designed in accordance with acceptable engineering practice and is in good condition.

In accordance with the Corps of Engineers' evaluation guidelines, the spillway capacity is inadequate for passing the PMF (Probable Maximum Flood) peak inflow without overtopping the dam. It is, however, capable of passing 46 percent of the PMF peak inflow. Because the dam is not a "High" hazard and because 1/2 PMF will not cause failure, the spillway is not considered to be seriously inadequate.

B. Adequacy of Information

The information available for review is considered to be adequate to make a reasonable assessment of the project.

C. Urgency

It is considered that the recommended suggestions in this section should be implemented without delay.

D. Necessity for Additional Studies

Additional studies are not required at this time. However, attention should be given to the recommendations presented below.

7.2 RECOMMENDATIONS

A. Facilities

In order to assure a continued satisfactory operation of these facilities the following recommendations are made for implementation by the owner:

1. The stem on the drawdown sluice gate should be repaired immediately to facilitate the use of this gate during emergencies.

2. Riprap of sufficient size should be placed at the end of the spillway slab to prevent future undermining of the slab.

3. The wet area adjacent to the spillway should be graded and a tile drain should be installed. The drain water should be visually monitored for quantity change and for turbidity.

B. Operation and Maintenance Procedures

The following procedures are recommended for implementation by the owner:

1. The drawdown sluice gate should be operated and maintained on a semi-annual basis.

2. Brush on the slopes should be removed and a maintenance schedule for control of weeds on the embankment slope should be established.

3. A formal surveillance and downstream warning system should be established to be used during periods of high or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 38-80 NDI NO. PA-00 603

NAME OF DAM Memorial Lake Dam HAZARD CATEGORY Low

TYPE OF DAM Earthfill

LOCATION East Hanover TOWNSHIP Lebanon COUNTY, PENNSYLVANIA

INSPECTION DATE 11-9-78 WEATHER Sunny TEMPERATURE 55° - 60°

INSPECTORS: H. Jongsma (Recorder) OWNER'S REPRESENTATIVE(s):

A. Bartlett Ron Hamilton (D.E.R.)

R. Steacy Robert Holden (Park Foreman)

NORMAL POOL ELEVATION: 430.0 AT TIME OF INSPECTION:

BREAST ELEVATION: 438.0 POOL ELEVATION: 430.0

SPILLWAY ELEVATION: 430.0 TAILWATER ELEVATION: 40.3

MAXIMUM RECORDED POOL ELEVATION: No records.

GENERAL COMMENTS:

Presently owned by Military Affairs, Pa. In the process of transferring to PennDER, Bureau of Operations.
No surveillance and downstream warning system.

NDI NO. PA-00 603

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None detected.
B. UNUSUAL MOVEMENT BEYOND TOE	None detected. See "G".
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	 Good. Good, a few tenths variation.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	Soft spot near right wall of stilling basin.
H. DRAINS	None evident.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Upstream - loose small stones - some weeds and brush. Breast - blacktop and concrete railing. Downstream - loose small stone- some weeds & brush.

NDI NO. PA-00 603

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Square concrete tower at upstream side of dam.
B. OUTLET STRUCTURE	Concrete headwall and wingwall.
C. OUTLET CHANNEL	Enters downstream channel from spillway about 250 feet from outlet channel in good condition.
D. GATES	48-inch unseated gate, leaking. Gate stem bent at several places. Stem guide torn loose from concrete. Unoperable. Operator stand operates a weir in a separate chamber.
E. EMERGENCY GATE	48-inch gate unoperable.
F. OPERATION & CONTROL	Gate was cracked open in August, 1978. Weir is operable.
G. BRIDGE (ACCESS)	None.

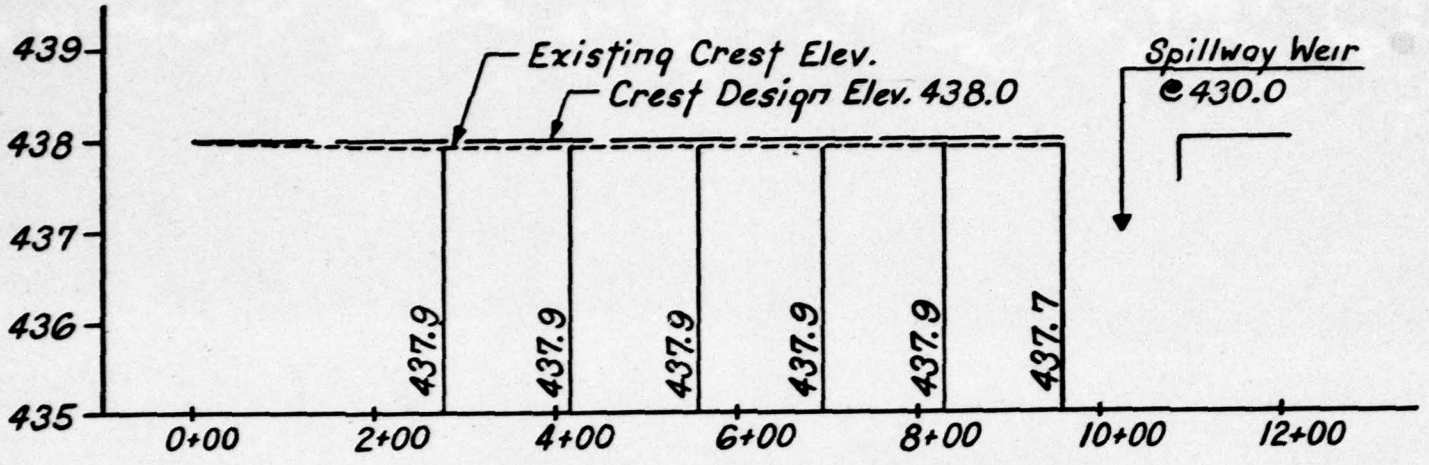
VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Concrete walls unobstructed.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	 Good, except some spalling. None. Some spalling. Not observed. Some deterioration at joint with abutment wall.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	 Concrete walls and slab. Some cracking & spalling, no structural deficiency. Good, except some erosion directly downstream which undermined slab. Probed 6 feet at one location.
D. BRIDGE & PIERS	Footbridge with solid concrete parapets and two concrete piers.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	No records.

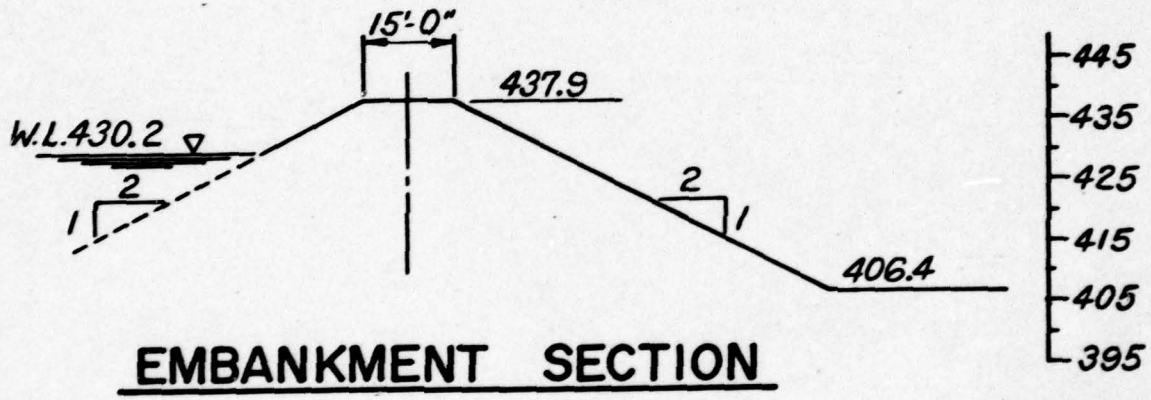
NDI NO. PA-00 603

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	
RESERVOIR	
Slopes	Flat, park. Well maintained grass.
Sedimentation	Sedimentation in the upper part of lake (Lake Marquette).
Watershed Description	Wooded and a small (15 acre) reservoir.
DOWNSTREAM CHANNEL	
Condition	Wide and flat. 2-arch bridge downstream. Damage downstream controlled by arch on I-81 which would stop a flood wave.
Slopes	Flat until bridge. Wooded beyond the road.
Approximate Population	Eight in Indiantown Gap. No additional loss of life expected due to presence of Interstate Route 81.
No. Homes	2 in Indiantown Gap.



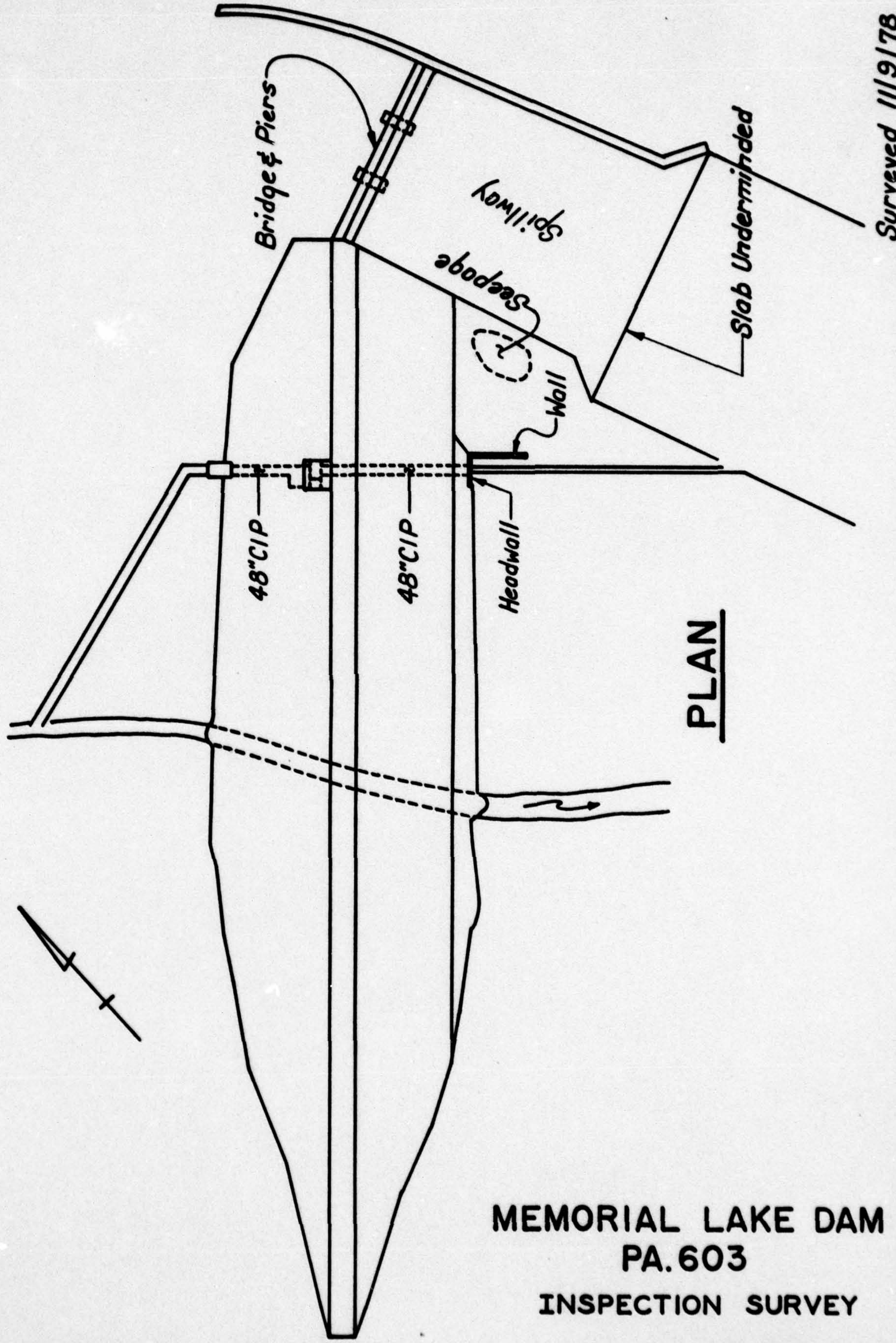
EMBANKMENT PROFILE



EMBANKMENT SECTION

Surveyed 11/9/78

MEMORIAL LAKE DAM
PA. 603
INSPECTION SURVEY
PLATE A-I



MEMORIAL LAKE DAM
PA.603
INSPECTION SURVEY

PLATE A-II

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 38-80 NDI NO. PA-00 603

NAME OF DAM MEMORIAL LAKE DAM

ITEM	REMARKS
AS-BUILT DRAWINGS	Not available, except construction drawings. See Appendix F, Plates III and IV.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle Indiantown Gap, PA See Plate II, Appendix F.
CONSTRUCTION HISTORY	Designed by Gannett, Fleming, Corddry & Carpenter, Harrisburg, Pa. Construction started June 1945 and completed in June 1946, contractor unknown.
GENERAL PLAN OF DAM	Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	Appendix F, Plate IV.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	 Appendix F, Plate IV. Appendix F, Plate IV. None. None.

NDI NO. PA-00 603

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	None, except report on application for permit to construct a dam by DER. The designer did not have design calculations.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	Inspection Reports by PennDER.
BORROW SOURCES	Unknown.

NDI NO. PA-00 603

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Construction of bridge across spillway included with general construction. Cutoff constructed higher than shown on plans because of poor quality of fill. Installed blacktop paving and handrail on top of dam.
HIGH POOL RECORDS	Unknown.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	Appendix F, Plate III.

NDI NO. PA-00 603

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	Appendix F, Plate IV.
CONSTRUCTION RECORDS	A few progress reports by PennDER.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports by PennDER. Seepage at toe near right spillway wall. Poor drainage beyond toe. Some deterioration of concrete of bridge piers and spillway wall. Loosening of stem guide of 48-inch sluice gate.
MISCELLANEOUS	

NDI NO. PA-00 603

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded and an upstream reservoir (Lake Marquette)

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 430; 1680 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 438; 2575 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 438

TOP DAM: Elev. 438

SPILLWAY:

a. Elevation 430

b. Type Uncontrolled ogee weir.

c. Width 110 feet including 2 bridge piers of 1.5 feet.

d. Length 34 feet plus stilling basin.

e. Location Spillover Left abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type Concrete control tower and 48-inch conduit.

b. Location 150 feet right of spillway.

c. Entrance inverts 402

d. Exit inverts 401

e. Emergency drawdown facilities 48-inch sluice gate.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location None.

c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: 8,300 cfs.

APPENDIX D

GEOLOGIC REPORT

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

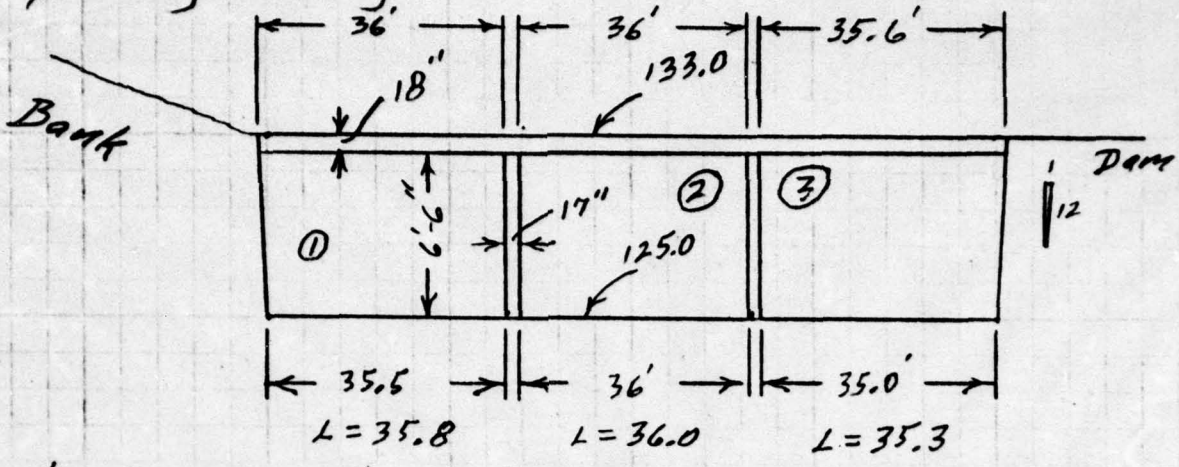
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

PROJECT Dam Safety Inspection SHEET NO. 1 OF

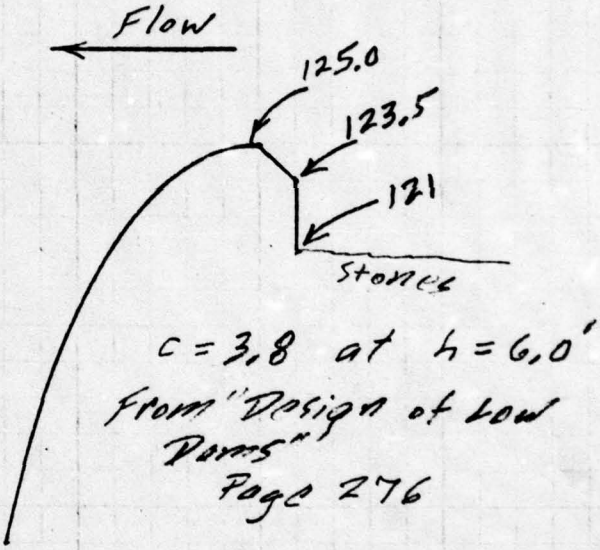
SUBJECT Memorial Lake - ID No. 603

COMPUTED BY RES DATE 11-14-78 CHECKED BY JJP 11-28-78

Spillway Rating



All elevations are to Project datum
Add 305 for m.s.l.



c = 3.8 at h = 6.0'
From "Design of Low Dams"
Page 276

Pool at 131

H = 131 − 125 = 6.0

$Q = CLH^{3/2}$

① $= 3.8 \times 35.8 \times (6)^{3/2}$
$= 2,000$ cfs

② $= 3.8 \times 36.0 \times (6)^{3/2}$
$= 2,011$ cfs

③ $= 3.8 \times 35.3 \times (6)^{3/2}$
$= 1971$

Total = 5982 cfs. Use 6,000 cfs

Pool at 133 (top of dam)

$Q = C a \sqrt{2gh}$ $C = 0.6$ $h = 1.5 + 3.25 = 4.75$

① $= 0.6 \times 6.5 \times 35.8 \times (64.3 \times 4.75)^{1/2} = 2440$ cfs

② $= 0.6 \times 6.5 \times 36 \times (64.3 \times 4.75)^{1/2} = 2454$ cfs

③ $= 0.6 \times 6.5 \times 35 \times (64.3 \times 4.75)^{1/2} = 2406$ cfs

Total = 7,300 cfs

SUBJECT Memorial Lake - ID No. 603

COMPUTED BY RES DATE 11-14-78 CHECKED BY JJPJr 11-28-78

Maximum known flood

At USGS gaging sta. at Harpers Tavern 2.0 mi. downstream the flood of record occurred on June 22, 1972

Drainage area = 337 sq. mi

Q = 66,700 cfs

For this dam site drain area = 7.87

$$Q = \left(\frac{7.87}{337}\right)^{.8} \times 66{,}700 = 3{,}302 \text{ cfs}$$

Use 3,300 cfs. Inflow

Outlet works

48-inch C.I. Pipe extends 137 feet through embankment. It passes through gate valve and 9-foot by 5-foot tower compartment 45 feet from upstream end.

Pool elevation 102

$h = 102 - 98 = 4$ ft.

$L = 137$ ft.

$n = 0.015$ $K = 0.5$ (2 times)

$$h = 2.87 (n)^2 \frac{L V^2}{d^{4/3}} + 2K \frac{V^2}{2g}$$

$$4 = \left[\frac{2.87 \times (0.015)^2 \times 137}{(4)^{4/3}} + 2 \times \frac{0.5}{64.3}\right] V^2$$

$$= \left[\frac{2.87 \times 0.000225 \times 137}{6.350} + 0.015552\right] V^2$$

$$= (0.0139 + 0.015552) V^2 = 0.0295 V^2$$

$$V^2 = \frac{4}{0.0295}, \quad V = \sqrt{136} = 11.7 \text{ ft/sec}$$

$$Q = VA = 11.7 \times \pi \times (2)^2 = 147 \text{ cfs}$$

Use 150 cfs.

SUBJECT Memorial Lake - ID No. 603 SHEET NO. 5

COMPUTED BY RES DATE 11-14-78 CHECKED BY JJPJr 11-28-78

Outlet works (cont'd)

Pool Elev. 125 (Spillway crest)

$h = 125 - 98 = 27$ ft.

$27 = 0.0295\ V^2$

$V^2 = \frac{27}{0.0295} = 915$

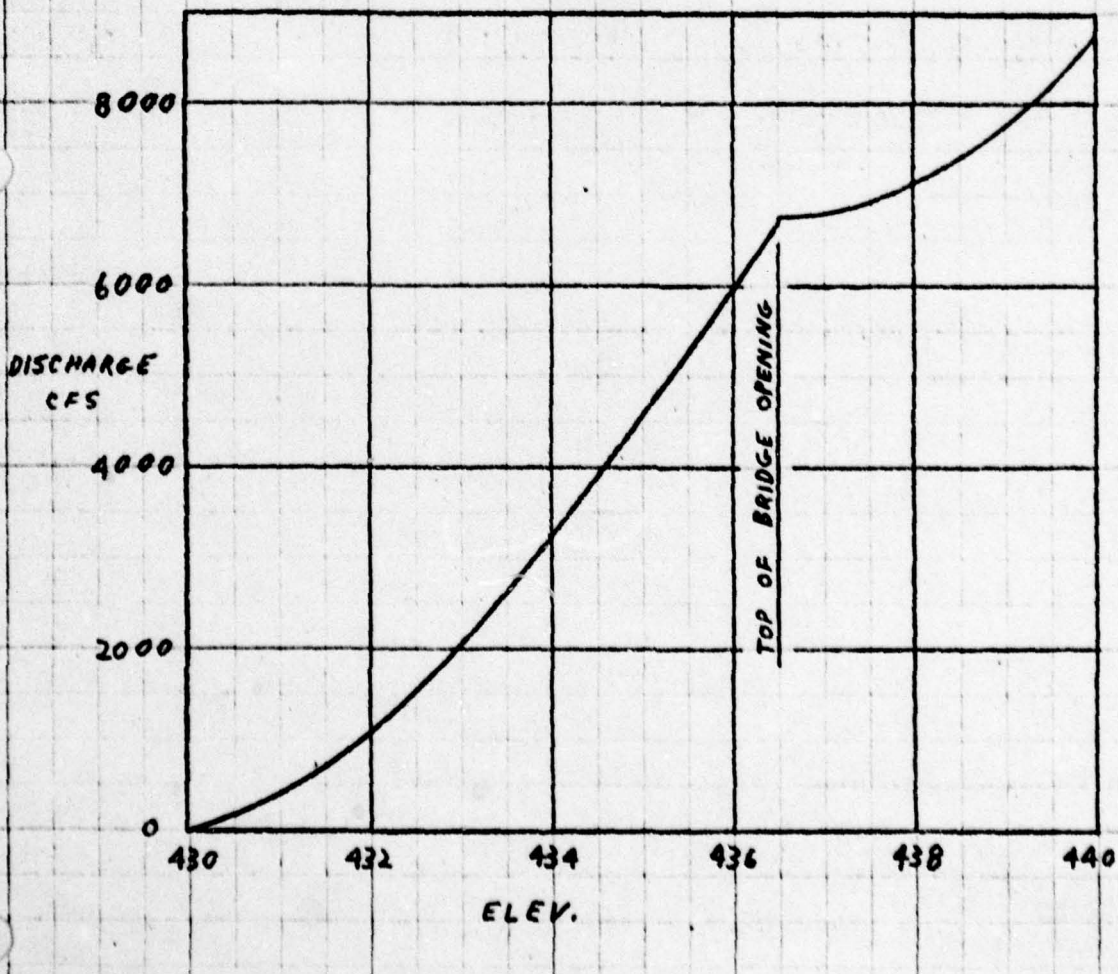
$V = 30.25$ ft/sec

$Q = VA = 30.25 \times \pi \times (2)^2 = 380$ cfs

BY DJR DATE 11/26/79 | BERGER ASSOCIATES | SHEET NO. 1 OF 2
CHKD. BY DATE | PROJECT DB490
SUBJECT MEMORIAL LAKE DAM

Spillway Rating (FOR USE IN HEC1)

Elevation	Discharge (cfs)
430	0
431	407
432	1151
434	3256
436	5982
436.5	6744
437.5	6910
438	7305
440	8709



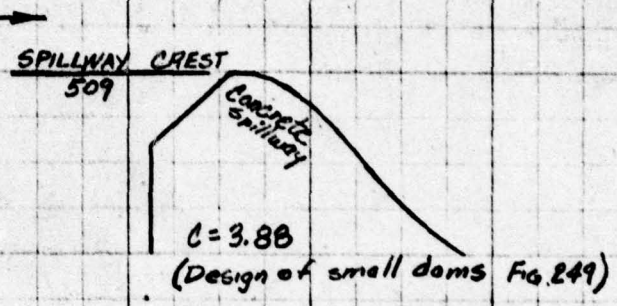
BY DNR DATE 1/25/79 **BERGER ASSOCIATES** SHEET NO. 5 OF 6
CHKD. BY DATE PROJECT DB490
SUBJECT MEMORIAL LAKE DAM

SPILLWAY CAPACITY OF MARQUETTE LAKE DAM:

$C = 3.88$
$L = 99.5'$
$H = 9'$

$Q = CLH^{3/2}$

$Q = 3.88 \times 99.5 \times 9^{3/2} = 10423$



Road Bridge spans the spillway, low chord is steel beam, use $C = .65$

$Q = CA\sqrt{2gh}$

Top of embankment is smooth road, use $C = 2.8$, $L = 1040'$

$Q = C L H^{3/2}$

Combined spillway and embankment rating curve: (for use in HEC 1 program)

	Elevation	Discharge (cfs)
	509	0
	510	386
	511	1092
	512	2006
	514	4316
	516	7150
TOP OF DAM (518)	518	10423
	519	13867
	520	20145
	521	27924

CHKD. BY _____ DATE _____ PROJECT 084

SUBJECT MEMORIAL LAKE

SIZE CLASSIFICATION

MAXIMUM STORAGE = 2575 ACRE-FEET

MAXIMUM HEIGHT = 37 FEET

SIZE CLASSIFICATION IS INTERMEDIATE

HAZARD CLASSIFICATION

NO HOUSES ARE NEAR THE DOWNSTREAM CHANNEL BETWEEN THE DAM AND THE EMBANKMENT OF THE INTERSTATE HIGHWAY THAT CROSSES THE STREAM; HOWEVER, CONSIDERABLE ECONOMIC LOSS. USE "SIGNIFICANT"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO ONE-HALF OF THE PMF TO THE PMF.

HEC-1 DATA

DRAINAGE AREA = 7.9 SQ. MI.
MEMORIAL LAKE SUBAREA = 2.1 SQ. MI.
MARQUETTE LAKE SUBAREA = 5.8 SQ. MI.

SUSQUEHANNA BASIN REGION 15B
$C_P = 0.85$
$C_T = 2.2$

MARQUETTE SUBAREA
LONGEST WATERCOURSE = 3.56 MI.
L TO CENTROID = 2.05 MI.

$T_P = C_T (L \times L_{CA})^{.3}$
$T_P = 3.99$

MEMORIAL SUBAREA
LONGEST WATERCOURSE = 2.2 MI.
L TO CENTROID = 1.08 MI.

$T_P = C_T (L \times L_{CA})^{.3}$
$T_P = 2.85$

RAINFALL (HMR-33)
INDEX = 23.2"

ZONE 6

INCREMENTAL RAINFALL
6 HR = 113 %
12 HR = 123 %
24 HR = 132 %
48 HR = 143 %

HEC-1 DATA

MARQUETTE LAKE

PLANIMETERED AREAS (FROM QUAD SHEET)
ELEV: 509 = 16.53 ACRES
520 = 30.3 ACRES
ZERO STORAGE ELEVATION
ELEV. = 509 - (STORAGE x3/AREA)
= 497.8

MEMORIAL LAKE

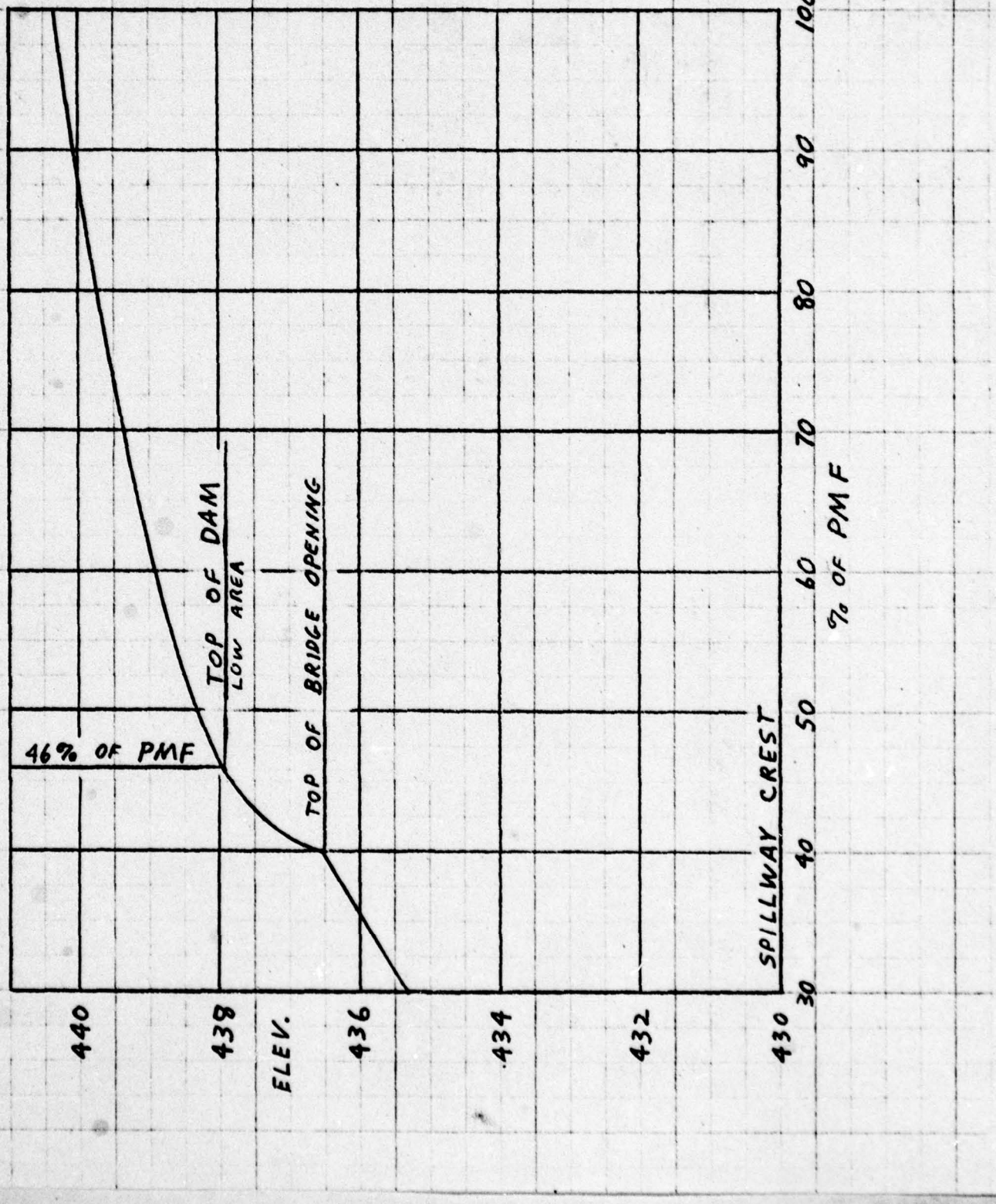
PLANIMETERED AREAS (FROM QUAD SHEET).
ELEV: 430 = 87 ACRES
440 = 164 ACRES
ZERO STORAGE ELEVATION
ELEV. = 430 - (STORAGE x3/AREA)
= 372.1

BY R.L.S. DATE 2/27/79 | BERGER ASSOCIATES | SHEET NO. 5 OF 12

CHKD. BY ____ DATE ____ | PROJECT D8490

SUBJECT MEMORIAL LAKE

SPILLWAY CAPACITY



ANALYSIS 1/8

```
**********
    1        A1       MEMORIAL LAKE DAM #### INDIANTOWN RUN
    2        A2       EAST HANOVER TWP., LEBANON COUNTY
    3        A3       NDI # PA00603   PA DER # 38-80
    4        B   300      0     15      0      0      0      0      0     -4      0
    5        B1    5
    6        J     1      9      1
    7        J1    1     .9     .8     .7     .6     .5     .4     .3    .15
    8        K             1                                     1
    9        K1                 INFLOW HYDROGRAPH - SUB AREA TO MARQUETTE LAKE
   10        M     1      1    5.8            7.9
   11        P           23.2    113    123    132    143
   12        T                                                  1    .05
   13        W  3.99    .85
   14        X  -1.5   -.05      2
   15        K     1      2                                     1
   16        K1                 RESERVOIR ROUTING - THRU MARQUETTE LAKE
   17        Y                                 1
   18        Y1    1                                                61.6    -1
   19        Y4  509    510    511    512    514    516    518    519    520    521
   20        Y5    0    386   1092   2006   4316   7150  10423  13867  20145  27924
   21        $A    0  16.53   30.3
   22        $E 497.8    509    520
   23        $$  509
   24        $D  518
   25        K     1      3                                     1
   26        K1                 REACH 2 - 3
   27        Y                                 1      0
   28        Y1    1
   29        Y6  .06   .045     .1    454    480   2700   .018
   30        Y7    0    480    120    460    230    457    235    454    245    454
   31        Y7  250    457    300    460   1550    480
   32        K             4                                     1
   33        K1                 INFLOW HYDROGRAPH - SURAREA BELOW MARQUETT LAKE TO MEMORIAL LAKE
   34        M     1      1    2.1            7.9
   35        P           23.2    113    123    132    143
   36        T                                                  1    .05
   37        W  2.85    .85
   38        X  -1.5   -.05      2
   39        K     2      5                                     1
   40        K1                 COMBINE HYDROGRAPHS AT MEMORIAL LAKE
   41        K     1      6                                     1
   42        K1                 RESERVOIR ROUTING - MEMORIAL LAKE
   43        Y                                 1      0
   44        Y1    1                                                1680    -1
   45        Y4  430    431    432    434    436  436.5  437.5    438    440
   46        Y5    0    407   1151   3256   5982   6744   6910   7305   8709
   47        $A    0     87    139    164
   48        $E 372.1    430    438    440
   49        $$  430
   50        $D 437.9    2.6    1.5    958
 1 51        K    99
 1                  PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                    RUNOFF HYDROGRAPH AT          1
                    ROUTE HYDROGRAPH TO           2
                    ROUTE HYDROGRAPH TO           3
                    RUNOFF HYDROGRAPH AT          4
                    COMBINE  2 HYDROGRAPHS AT     5
                    ROUTE HYDROGRAPH TO           6
                    END OF NETWORK
```

MEMORIAL LAKE DAM #### INDIANTOWN RUN
EAST HANOVER TWP., LEBANON COUNTY
NDI # PA00603 PA DER # 38-80

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	MIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

########## ########## ########## ########## ##########

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUB AREA TO MARQUETTE LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	5.80	0.00	7.90	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 3.99 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 36 END-OF-PERIOD ORDINATES, LAG= 3.94 HOURS, CP= .81 VOL= 1.00

21.	75.	144.	216.	287.	355.	419.	480.	536.	590.
640.	687.	731.	765.	783.	788.	781.	765.	742.	713.
677.	637.	590.	536.	471.	384.	291.	217.	163.	121.
91.	68.	51.	38.	28.	21.				

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	363764.
										(674.)(613.)(61.)(10300.65)			

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU MARQUETTE LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	62.	-1

STAGE	509.0	510.0	511.0	512.0	514.0	516.0	518.0	519.0	520.0	521.
FLOW	0.	386.	1092.	2006.	4316.	7150.	10423.	13867.	20145.	27924
SURFACE AREA=	0.	17.	30.							
CAPACITY=	0.	62.	315.							
ELEVATION=	498.	509.	520.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
509.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
518.0	0.0	0.0	0.

PEAK OUTFLOW IS 13309. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 11976. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 10658. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 9282. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 7957. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 6629. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 5304. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 3975. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 1985. AT TIME 43.50 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0450	.1000	454.0	480.0	2700.	.01800

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 480.00 120.00 460.00 230.00 457.00 235.00 454.00 245.00 454.00
250.00 457.00 300.00 460.00 1550.00 480.00

STORAGE	0.	1.	2.	6.	16.	32.	56.	89.	129.	177
	232.	296.	368.	448.	536.	631.	735.	847.	966.	1094
OUTFLOW	0.	79.	275.	697.	1668.	3541.	6599.	10961.	16795.	24263
	33526.	44737.	58042.	73586.	91508.	111944.	135024.	160879.	189635.	221415
STAGE	454.0	455.4	456.7	458.1	459.5	460.8	462.2	463.6	464.9	466.
	467.7	469.1	470.4	471.8	473.2	474.5	475.9	477.3	478.6	480.
FLOW	0.	79.	275.	697.	1668.	3541.	6599.	10961.	16795.	24263
	33526.	44737.	58042.	73586.	91508.	111944.	135024.	160879.	189635.	221415

MAXIMUM STAGE IS 464.1

MAXIMUM STAGE IS 463.8

MAXIMUM STAGE IS 463.5

MAXIMUM STAGE IS 463.1

MAXIMUM STAGE IS 462.6

MAXIMUM STAGE IS 462.2

MAXIMUM STAGE IS 461.6

MAXIMUM STAGE IS 461.0

MAXIMUM STAGE IS 459.7

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUBAREA BELOW MARQUETT LAK

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.10	0.00	7.90	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.85 CP= .85 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 26 END-OF-PERIOD ORDINATES, LAG= 2.82 HOURS, CP= .81 VOL= 1.00

16.	57.	106.	156.	203.	247.	287.	324.	358.	385.
398.	399.	389.	372.	348.	319.	282.	232.	170.	117.
80.	54.	37.	25.	17.	12.				

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	131653.
										(674.)	(613.)	(61.)	(3728.00)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

RESERVOIR ROUTING - MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

HYDROGRAPH ROUTING

RESERVOIR ROUTING - MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	1680.	-1

STAGE	430.0	431.0	432.0	434.0	436.0	436.5	437.5	438.0	440.0
FLOW	0.	407.	1151.	3256.	5982.	6744.	6910.	7305.	8709.
SURFACE AREA=	0.	87.	139.	164.					
CAPACITY=	0.	1679.	2575.	2878.					
ELEVATION=	372.	430.	438.	440.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
430.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
437.9	2.6	1.5	958.

PEAK OUTFLOW IS 18319. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 16452. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 14514. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 12617. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 10598. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 8167. AT TIME 44.25 HOURS

PEAK OUTFLOW IS 6749. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 5063. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 2467. AT TIME 44.00 HOURS

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				1.00	.90	.80	.70	.60	.50	.40	.30	.15
HYDROGRAPH AT	1	5.80	1	13317.	11985.	10654.	9322.	7990.	6659.	5327.	3995.	1998.
		(15.02)		(377.10)(	339.39)(	301.68)(	263.97)(	226.26)(	188.55)(	150.84)(	113.13)(	56.56)
ROUTED TO	2	5.80	1	13309.	11976.	10658.	9282.	7957.	6629.	5304.	3975.	1985.
		(15.02)		(376.88)(	339.13)(	301.79)(	262.83)(	225.32)(	187.70)(	150.19)(	112.57)(	56.22)
ROUTED TO	3	5.80	1	13285.	11957.	10634.	9286.	7961.	6631.	5306.	3974.	1983.
		(15.02)		(376.19)(	338.58)(	301.12)(	262.96)(	225.44)(	187.76)(	150.24)(	112.55)(	56.16)
HYDROGRAPH AT	4	2.10	1	5768.	5191.	4614.	4037.	3461.	2884.	2307.	1730.	865.
		(5.44)		(163.33)(	146.99)(	130.66)(	114.33)(	98.00)(	81.66)(	65.33)(	49.00)(	24.50)
2 COMBINED	5	7.90	1	18495.	16643.	14697.	12855.	11024.	9168.	7341.	5491.	2735.
		(20.46)		(523.72)(	471.29)(	416.16)(	364.00)(	312.16)(	259.62)(	207.86)(	155.47)(	77.43)
ROUTED TO	6	7.90	1	18319.	16452.	14514.	12617.	10598.	8167.	6749.	5063.	2467.
		(20.46)		(518.74)(	465.87)(	410.99)(	357.27)(	300.10)(	231.27)(	191.12)(	143.36)(	69.87)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	508.98	509.00	518.00
	STORAGE	61.	62.	258.
	OUTFLOW	0.	0.	10423.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	518.84	.84	281.	13309.	3.50	43.25	0.00
.90	518.45	.45	270.	11976.	2.50	43.25	0.00
.80	518.07	.07	260.	10658.	1.00	43.25	0.00
.70	517.30	0.00	239.	9282.	0.00	43.50	0.00
.60	516.49	0.00	218.	7957.	0.00	43.25	0.00
.50	515.63	0.00	196.	6629.	0.00	43.50	0.00
.40	514.70	0.00	174.	5304.	0.00	43.50	0.00
.30	513.70	0.00	152.	3975.	0.00	43.50	0.00
.15	511.98	0.00	116.	1985.	0.00	43.50	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW(CFS)	MAXIMUM STAGE(FT)	TIME HOURS

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	518.84	.84	281.	13309.	3.50	43.25	0.00
.90	518.45	.45	270.	11976.	2.50	43.25	0.00
.80	518.07	.07	260.	10658.	1.00	43.25	0.00
.70	517.30	0.00	239.	9282.	0.00	43.50	0.00
.60	516.49	0.00	218.	7957.	0.00	43.25	0.00
.50	515.63	0.00	196.	6629.	0.00	43.50	0.00
.40	514.70	0.00	174.	5304.	0.00	43.50	0.00
.30	513.70	0.00	152.	3975.	0.00	43.50	0.00
.15	511.98	0.00	116.	1985.	0.00	43.50	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	13285.	464.1	43.25
.90	11957.	463.8	43.25
.80	10634.	463.5	43.50
.70	9286.	463.1	43.50
.60	7961.	462.6	43.50
.50	6631.	462.2	43.50
.40	5306.	461.6	43.50
.30	3974.	461.0	43.50
.15	1983.	459.7	43.50

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PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	430.01	430.00	437.90
STORAGE	1680.	1679.	2561.
OUTFLOW	3.	0.	7226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	440.32	2.42	2931.	18319.	5.75	43.25	0.00
.90	440.03	2.13	2882.	16452.	5.50	43.25	0.00
.80	439.70	1.80	2829.	14514.	5.00	43.50	0.00
.70	439.36	1.46	2775.	12617.	4.50	43.50	0.00
.60	438.94	1.04	2711.	10598.	3.50	43.75	0.00
.50	438.32	.42	2620.	8167.	1.75	44.25	0.00
.40	436.53	0.00	2379.	6749.	0.00	44.00	0.00
.30	435.33	0.00	2229.	5063.	0.00	44.00	0.00
.15	433.25	0.00	1993.	2467.	0.00	44.00	0.00

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78
****
EOI ENCOUNTERED.

LAST MODIFICATION 21 AUG 78

OVERTOPPING ANALYSIS
IMPROVED EMBANKMENT
1/8

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**********************************
    1   A1   MEMORIAL LAKE DAM #### INDIANTOWN RUN
    2   A2   EAST HANOVER TWP., LEBANON COUNTY
    3   A3   NDI # PA00603   PA DER # 38-80
    4   B   300     0    15     0     0     0     0     0    -4     0
    5   B1    5
    6   J     1     9     1
    7   J1    1    .9    .8    .7    .6    .5    .4    .3   .15
    8   K           1                             1
    9   K1            INFLOW HYDROGRAPH - SUB AREA TO MARQUETTE LAKE
   10   M     1     1   5.8           7.9
   11   P          23.2   113   123   132   143
   12   T                                       1   .05
   13   W  3.99   .85
   14   X  -1.5  -.05     2
   15   K     1     2                             1
   16   K1            RESERVOIR ROUTING - THRU MARQUETTE LAKE
   17   Y                       1
   18   Y1    1                                  61.6    -1
   19   Y4  509   510   511   512   514   516   518   519   520   521
   20   Y5    0   386  1092  2006  4316  7150 10423 13867 20145 27924
   21   $A    0 16.53  30.3
   22   $E 497.8   509   520
   23   $$  509
   24   $D  518
   25   K     1     3                             1
   26   K1            REACH 2 - 3
   27   Y                       1     0
   28   Y1    1
   29   Y6  .06  .045    .1   454   480  2700  .018
   30   Y7    0   480   120   460   230   457   235   454   245   454
   31   Y7  250   457   300   460  1550   480
   32   K           4                             1
   33   K1            INFLOW HYDROGRAPH - SUBAREA BELOW MARQUETT LAKE TO MEMORIAL LAKE
   34   M     1     1   2.1           7.9
   35   P          23.2   113   123   132   143
   36   T                                       1   .05
   37   W  2.85   .85
   38   X  -1.5  -.05     2
   39   K     2     5                             1
   40   K1            COMBINE HYDROGRAPHS AT MEMORIAL LAKE
   41   K     1     6                             1
   42   K1            RESERVOIR ROUTING - MEMORIAL LAKE
   43   Y                       1     0
   44   Y1    1                                  1680    -1
   45   Y4  430   431   432   434   436 436.5 437.5   438   440
   46   Y5    0   407  1151  3256  5982  6744  6910  7305  8709
   47   $A    0    87   139   164
   48   $E 372.1   430   438   440
   49   $$  430
   50   $D  438   2.6   1.5   958
  1 51   K    99
    1            PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                 RUNOFF HYDROGRAPH AT          1
                 ROUTE HYDROGRAPH TO           2
                 ROUTE HYDROGRAPH TO           3
                 RUNOFF HYDROGRAPH AT          4
                 COMBINE  2 HYDROGRAPHS AT     5
                 ROUTE HYDROGRAPH TO           6
                 END OF NETWORK
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MEMORIAL LAKE DAM #### INDIANTOWN RUN
EAST HANOVER TWP., LEBANON COUNTY
NDI # PA00603 PA DER # 38-80

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUB AREA TO MARQUETTE LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	5.80	0.00	7.90	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 3.99 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 36 END-OF-PERIOD ORDINATES, LAG= 3.94 HOURS, CP= .81 VOL= 1.00

21.	75.	144.	216.	287.	355.	419.	480.	536.	590.
640.	687.	731.	765.	783.	788.	781.	765.	742.	713.
677.	637.	590.	536.	471.	384.	291.	217.	163.	121.
91.	68.	51.	38.	28.	21.				

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	363764.
										(674.)(613.)(61.)(10300.65)			

########## ########## ########## ########## ##########

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU MARQUETTE LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	62.	-1

STAGE	509.0	510.0	511.0	512.0	514.0	516.0	518.0	519.0	520.0	521.0
FLOW	0.	386.	1092.	2006.	4316.	7150.	10423.	13867.	20145.	27924.
SURFACE AREA=	0.	17.	30.							
CAPACITY=	0.	62.	315.							
ELEVATION=	498.	509.	520.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
509.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
518.0	0.0	0.0	0.

PEAK OUTFLOW IS 13309. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 11976. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 10658. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 9282. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 7957. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 6629. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 5304. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 3975. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 1985. AT TIME 43.50 HOURS

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0450	.1000	454.0	480.0	2700.	.01800

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 480.00 120.00 460.00 230.00 457.00 235.00 454.00 245.00 454.00
250.00 457.00 300.00 460.00 1550.00 480.00

STORAGE	0.	1.	2.	6.	16.	32.	56.	89.	129.	177.
	232.	296.	368.	448.	536.	631.	735.	847.	966.	1094.
OUTFLOW	0.	79.	275.	697.	1668.	3541.	6599.	10961.	16795.	24263.
	33526.	44737.	58042.	73586.	91508.	111944.	135024.	160879.	189635.	221415.
STAGE	454.0	455.4	456.7	458.1	459.5	460.8	462.2	463.6	464.9	466.
	467.7	469.1	470.4	471.8	473.2	474.5	475.9	477.3	478.6	480.(
FLOW	0.	79.	275.	697.	1668.	3541.	6599.	10961.	16795.	24263.
	33526.	44737.	58042.	73586.	91508.	111944.	135024.	160879.	189635.	221415.

MAXIMUM STAGE IS 464.1

MAXIMUM STAGE IS 463.8

MAXIMUM STAGE IS 463.5

MAXIMUM STAGE IS 463.1

MAXIMUM STAGE IS 462.6

MAXIMUM STAGE IS 462.2

MAXIMUM STAGE IS 461.6

MAXIMUM STAGE IS 461.0

MAXIMUM STAGE IS 459.7

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUBAREA BELOW MARQUETT LAK

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.10	0.00	7.90	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.85 CP= .85 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 26 END-OF-PERIOD ORDINATES, LAG= 2.82 HOURS, CP= .81 VOL= 1.00

16.	57.	106.	156.	203.	247.	287.	324.	358.	385.
398.	399.	389.	372.	348.	319.	282.	232.	170.	117.
80.	54.	37.	25.	17.	12.				

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	131653.
										(674.)	(613.)	(61.)	(3728.00)

****

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	2	0	0	0	0	1	0	0

****

HYDROGRAPH ROUTING

RESERVOIR ROUTING - MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING - MEMORIAL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

DLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	1680.	-1

STAGE	430.0	431.0	432.0	434.0	436.0	436.5	437.5	438.0	440.0
FLOW	0.	407.	1151.	3256.	5982.	6744.	6910.	7305.	8709.
SURFACE AREA=	0.	87.	139.	164.					
CAPACITY=	0.	1679.	2575.	2878.					
ELEVATION=	372.	430.	438.	440.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
430.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
438.0	2.6	1.5	958.

PEAK OUTFLOW IS 18314. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 16445. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 14508. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 12603. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 10570. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 8101. AT TIME 44.25 HOURS

PEAK OUTFLOW IS 6749. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 5063. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 2467. AT TIME 44.00 HOURS

********** ********** ********** ********** **********

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO
				1.00	.90	.80	.70	.60	.50	.40	.30	.1
HYDROGRAPH AT	1	5.80	1	13317.	11985.	10654.	9322.	7990.	6659.	5327.	3995.	1998.
		(15.02)		(377.10)(	339.39)(	301.68)(	263.97)(	226.26)(	188.55)(	150.84)(	113.13)(	56.56
ROUTED TO	2	5.80	1	13309.	11976.	10658.	9282.	7957.	6629.	5304.	3975.	1985.
		(15.02)		(376.88)(	339.13)(	301.79)(	262.83)(	225.32)(	187.70)(	150.19)(	112.57)(	56.22
ROUTED TO	3	5.80	1	13285.	11957.	10634.	9286.	7961.	6631.	5306.	3974.	1983.
		(15.02)		(376.19)(	338.58)(	301.12)(	262.96)(	225.44)(	187.76)(	150.24)(	112.55)(	56.16
HYDROGRAPH AT	4	2.10	1	5768.	5191.	4614.	4037.	3461.	2884.	2307.	1730.	865.
		(5.44)		(163.33)(	146.99)(	130.66)(	114.33)(	98.00)(	81.66)(	65.33)(	49.00)(	24.50
2 COMBINED	5	7.90	1	18495.	16643.	14697.	12855.	11024.	9168.	7341.	5491.	2735.
		(20.46)		(523.72)(	471.29)(	416.16)(	364.00)(	312.16)(	259.62)(	207.86)(	155.47)(	77.43
ROUTED TO	6	7.90	1	18314.	16445.	14508.	12603.	10570.	8101.	6749.	5063.	2467.
		(20.46)		(518.60)(	465.67)(	410.82)(	356.86)(	299.32)(	229.39)(	191.12)(	143.36)(	69.87

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	508.98	509.00	518.00
STORAGE	61.	62.	258.
OUTFLOW	0.	0.	10423.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	518.84	.84	281.	13309.	3.50	43.25	0.00
.90	518.45	.45	270.	11976.	2.50	43.25	0.00
.80	518.07	.07	260.	10658.	1.00	43.25	0.00
.70	517.30	0.00	239.	9282.	0.00	43.50	0.00
.60	516.49	0.00	218.	7957.	0.00	43.25	0.00
.50	515.63	0.00	196.	6629.	0.00	43.50	0.00
.40	514.70	0.00	174.	5304.	0.00	43.50	0.00
.30	513.70	0.00	152.	3975.	0.00	43.50	0.00
.15	511.98	0.00	116.	1985.	0.00	43.50	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW(CFS)	MAXIMUM STAGE(FT)	TIME HOURS

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	518.84	.84	281.	13309.	3.50	43.25	0.00
.90	518.45	.45	270.	11976.	2.50	43.25	0.00
.80	518.07	.07	260.	10658.	1.00	43.25	0.00
.70	517.30	0.00	239.	9282.	0.00	43.50	0.00
.60	516.49	0.00	218.	7957.	0.00	43.25	0.00
.50	515.63	0.00	196.	6629.	0.00	43.50	0.00
.40	514.70	0.00	174.	5304.	0.00	43.50	0.00
.30	513.70	0.00	152.	3975.	0.00	43.50	0.00
.15	511.98	0.00	116.	1985.	0.00	43.50	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	13285.	464.1	43.25
.90	11957.	463.8	43.25
.80	10634.	463.5	43.50
.70	9286.	463.1	43.50
.60	7961.	462.6	43.50
.50	6631.	462.2	43.50
.40	5306.	461.6	43.50
.30	3974.	461.0	43.50
.15	1983.	459.7	43.50

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	430.01	430.00	438.00
STORAGE	1680.	1679.	2575.
OUTFLOW	3.	0.	6967.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	440.41	2.41	2946.	18314.	5.75	43.25	0.00
.90	440.11	2.11	2896.	16445.	5.25	43.25	0.00
.80	439.79	1.79	2843.	14508.	5.00	43.50	0.00
.70	439.44	1.44	2788.	12603.	4.25	43.50	0.00
.60	439.02	1.02	2723.	10570.	3.50	43.75	0.00
.50	438.37	.37	2627.	8101.	1.75	44.25	0.00
.40	436.53	0.00	2379.	6749.	0.00	44.00	0.00
.30	435.33	0.00	2229.	5063.	0.00	44.00	0.00
.15	433.25	0.00	1993.	2467.	0.00	44.00	0.00

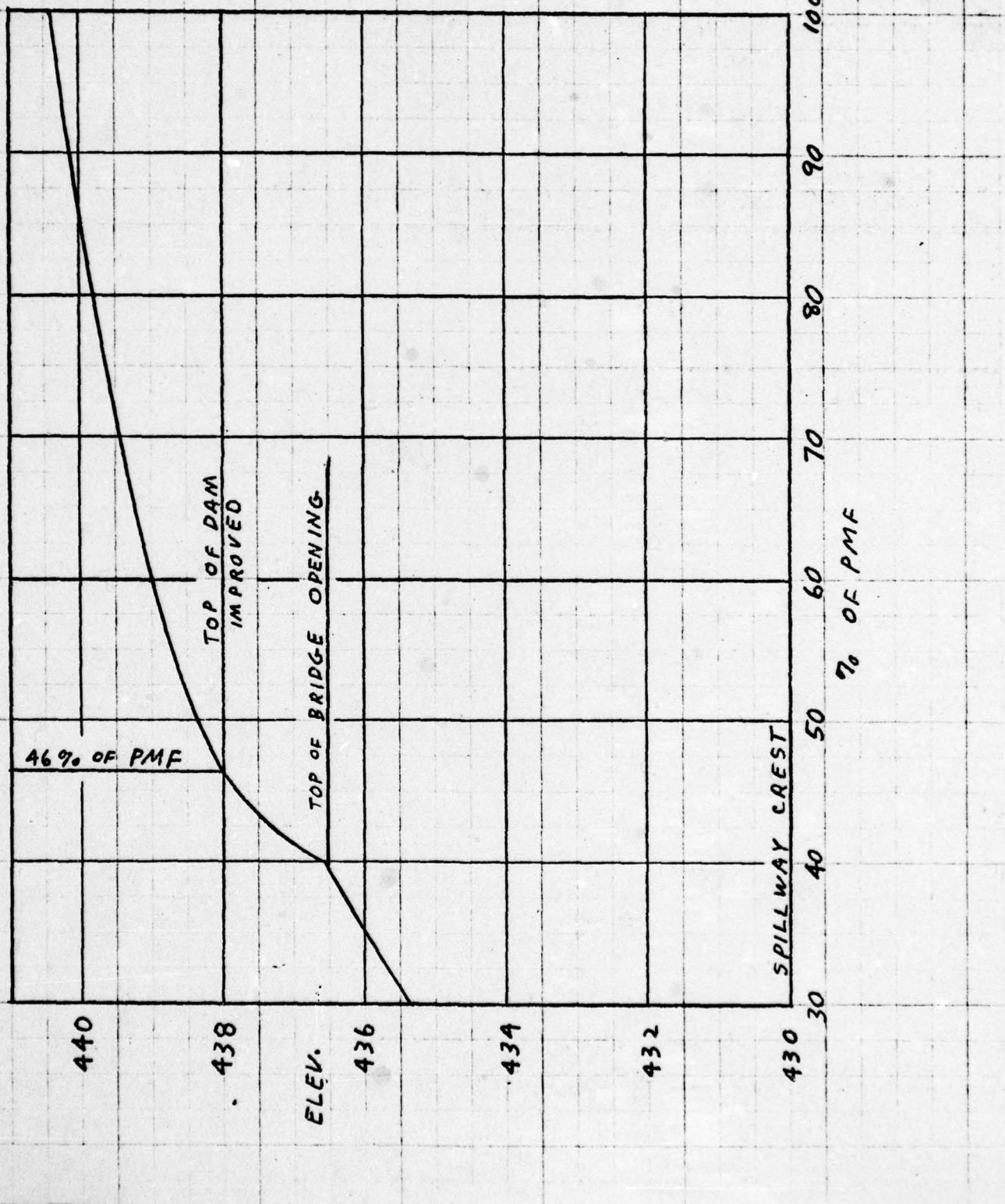
1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78
****
EOI ENCOUNTERED.

BY RLS DATE 2/27/79 **BERGER ASSOCIATES** SHEET NO. OF

CHKD. BY DATE PROJECT D8490

SUBJECT MEMORIAL LAKE

SPILLWAY CAPACITY
IMPROVED EMBANKMENT



APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Martinsburg Formation.

Lithology: The Martinsburg Formation here is a medium to dark gray shale with some siltstone interbeds. It weathers to splintery fragments, light gray to olive gray in color.

Structure

The bedrock here is tightly folded and faulted. The overall strike of the beds is about N50°E, nearly parallel to the dam axis. This area has not been mapped in detail, therefore, it is not known whether any faults exist in the immediate area of the dam.

Air Photo fracture traces trend N80°W, N30°W and N30°E.

Overburden

No coring information is available for this dam. Overburden probably consisted of weathered shale and some alluvium. The Martinsburg Formation is usually not deeply weathered in this area.

Aquifer Characteristics

The Martinsburg shale is an essentially impermeable rock and ground water movement is along secondary fractures, joints and cleavage. The upper weathered zone is usually quite permeable, and in the unweathered shale major fracture zones can also be quite permeable.

Discussion

The plans for this dam called for a cutoff trench and wall, placed at least three feet into fresh rock. Inspection reports confirm that the trench was dug into fresh rock. Inspections after completion indicate some leakage, apparently through the rock. This is possible, due to the N30°W fractures in the area of the dam. Continued seepage along these fractures is not likely to increase in volume or decompose the minerals of the rock.

Sources of Information

1. Geologic Map of Indiantown Gap Quadrangle (1977). Open file. Pa. Geological Survey.

2. Air Photos. Scale, 1:24,000. 1969.

3. Plans and reports in file.

GEOLOGIC MAP - Memorial Lake Dam

(geology from Pa. Geol. Survey - open file)

Om — Martinsburg Fm.

Ohgs — Hamburg Sequence- greywacke

Oh — Hamburg Sequence- shale

fault

air photo fracture trace

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

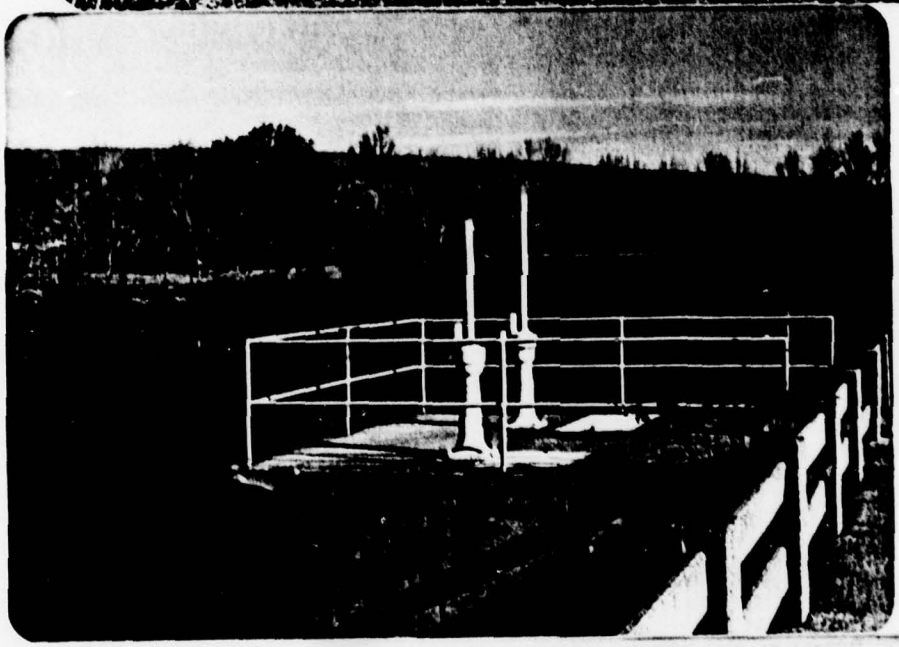
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

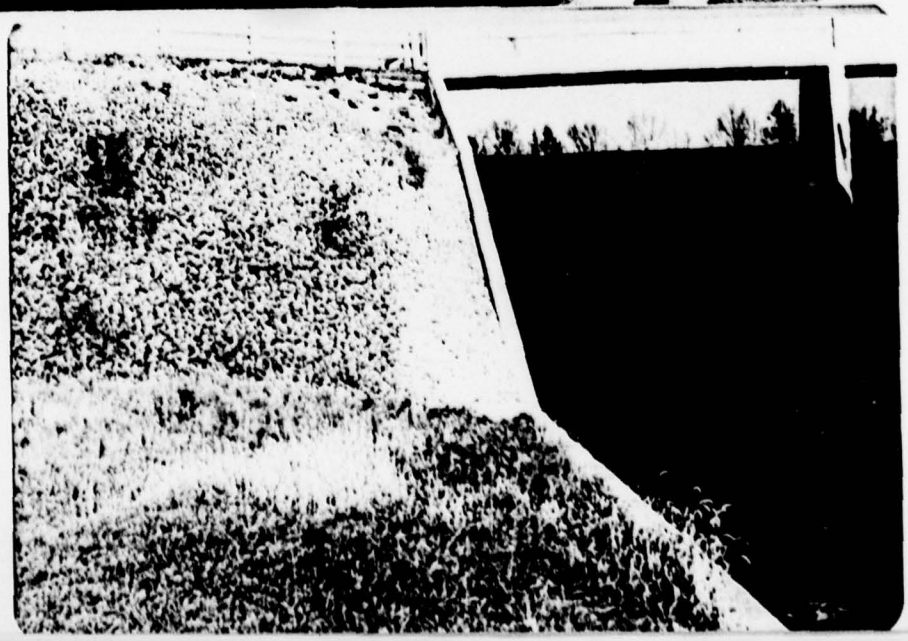
APPENDIX E

PHOTOGRAPHS

Right Abutment
& Upstream Slope



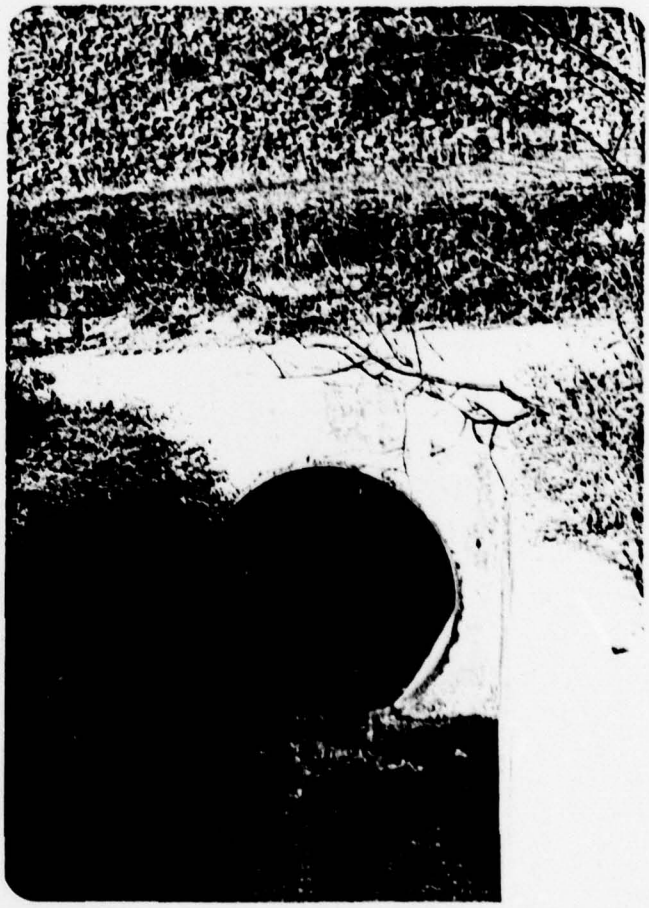
Control Tower



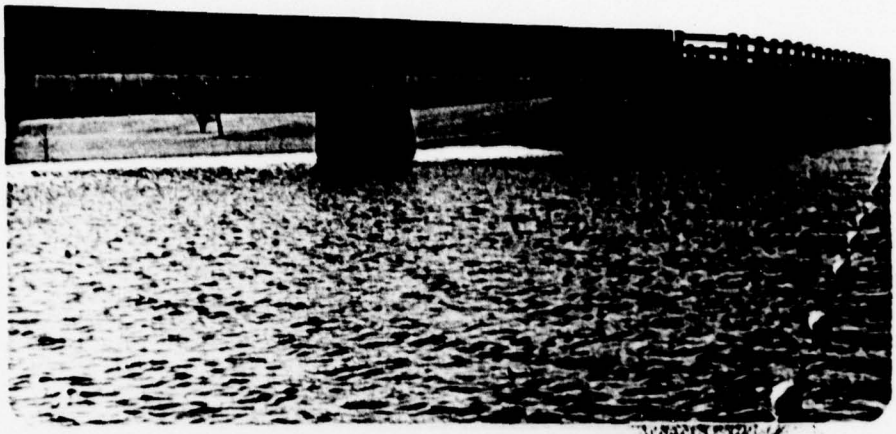
Wet Area at Toe
Near Spillway

PA-603
PLATE E-1

Conduit Outlet Channel

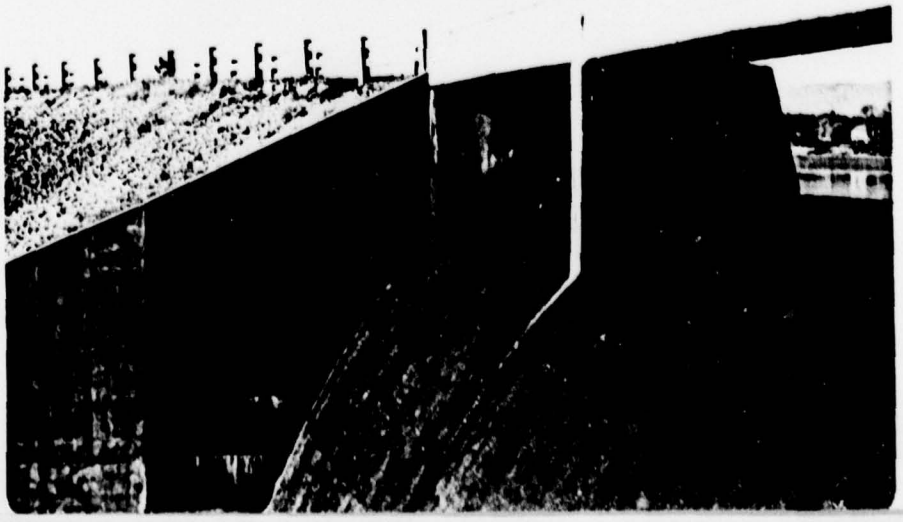


Conduit Outlet



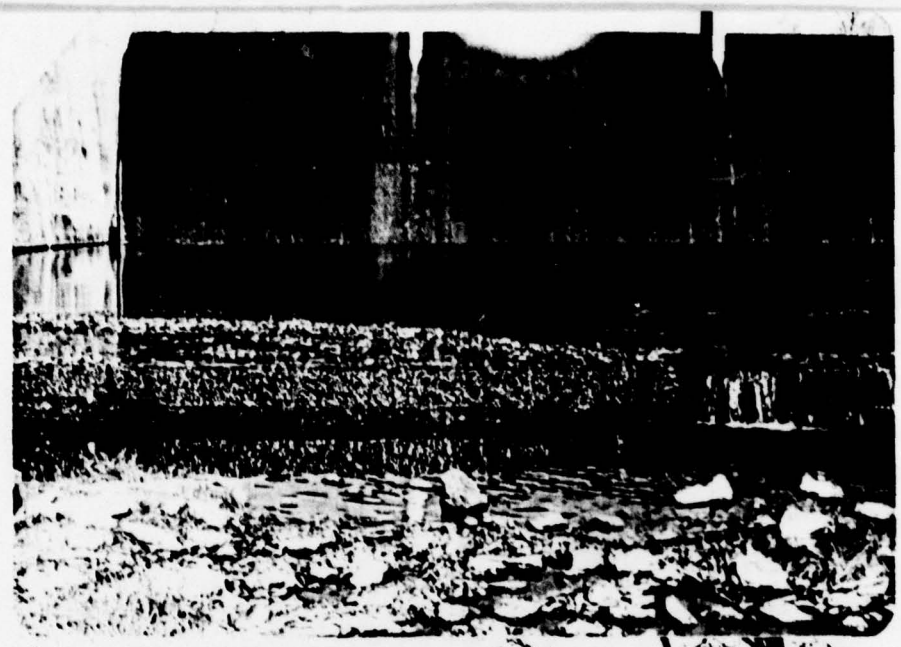
Forebay Area

Left Spillway
Wall



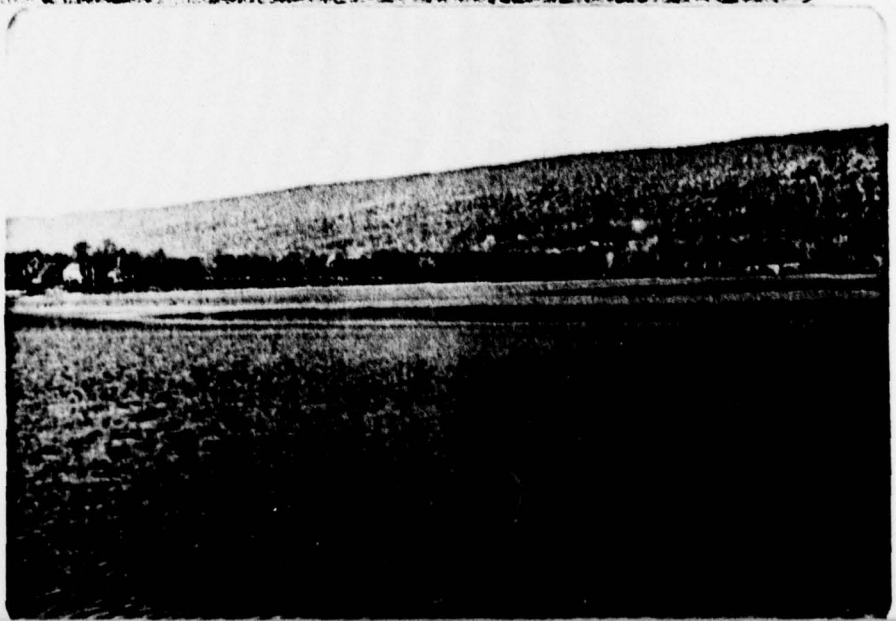
Right Spillway
Wall

PA-603
PLATE E-111



Undermining of
Slab Beyond
Stilling Basin

Downstream Channel

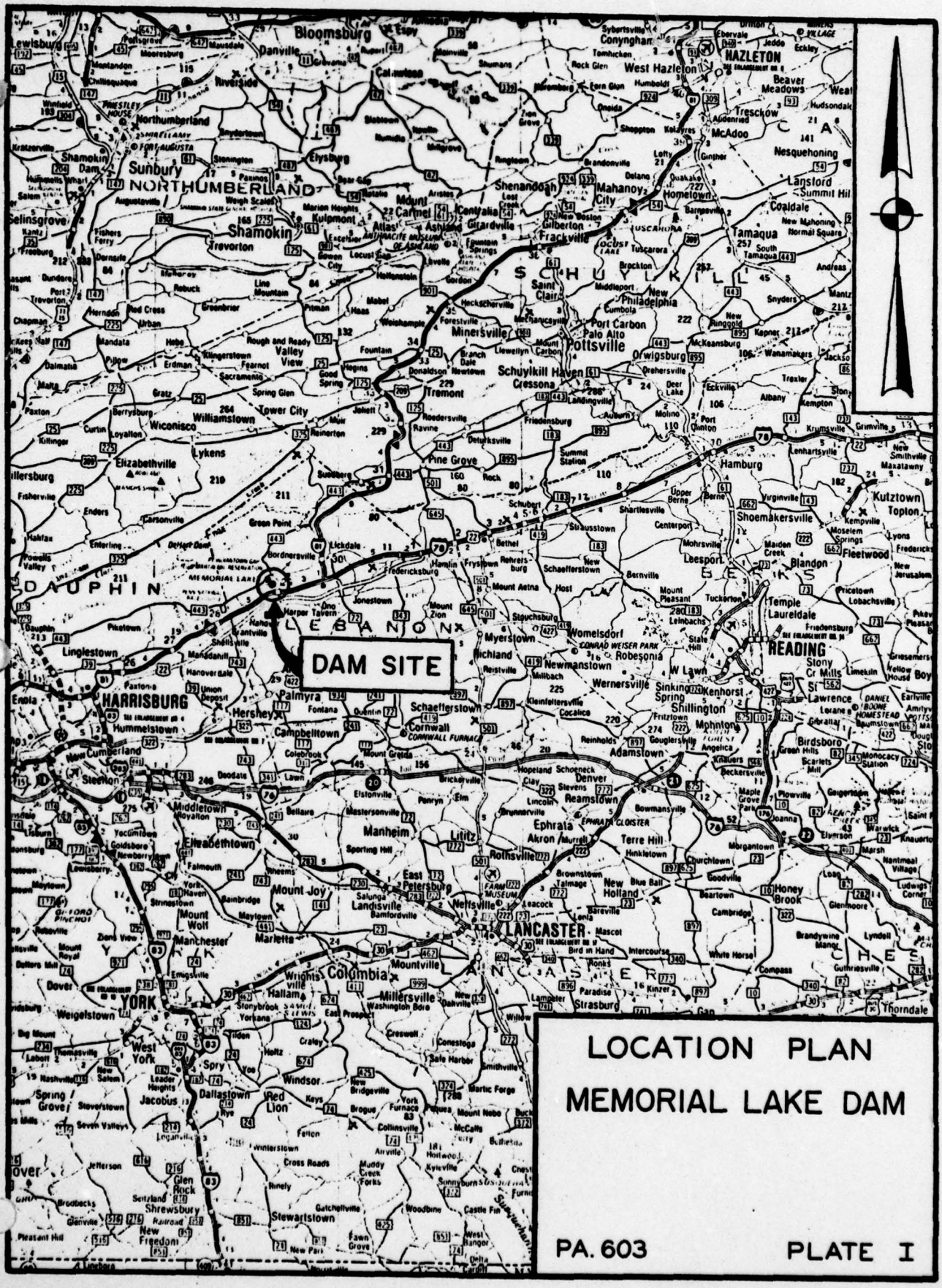


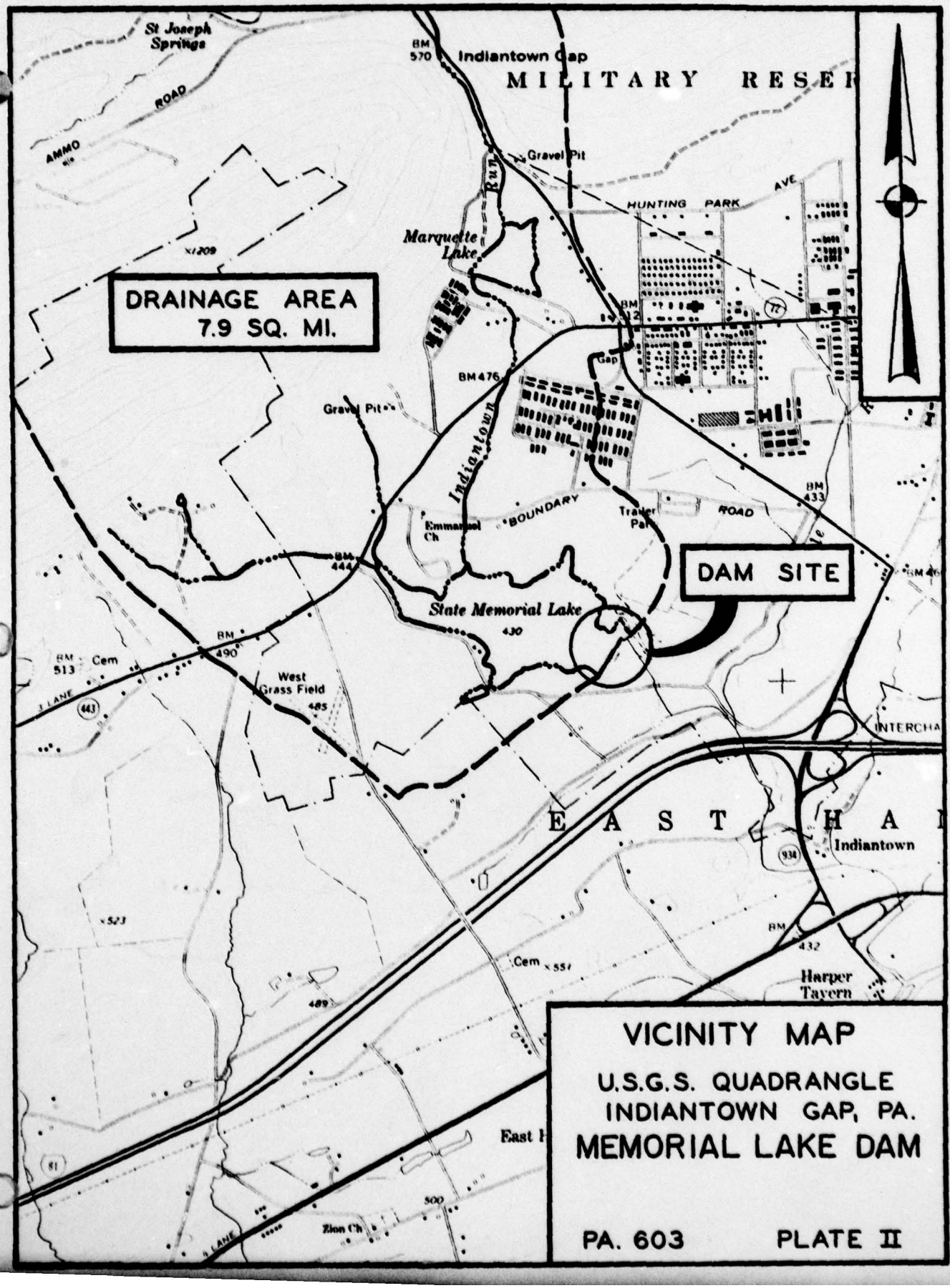
Reservoir

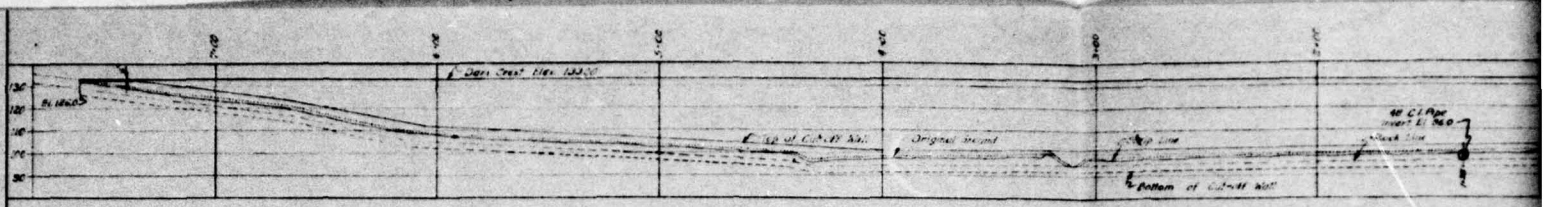
PA-603
PLATE E-IV

APPENDIX F

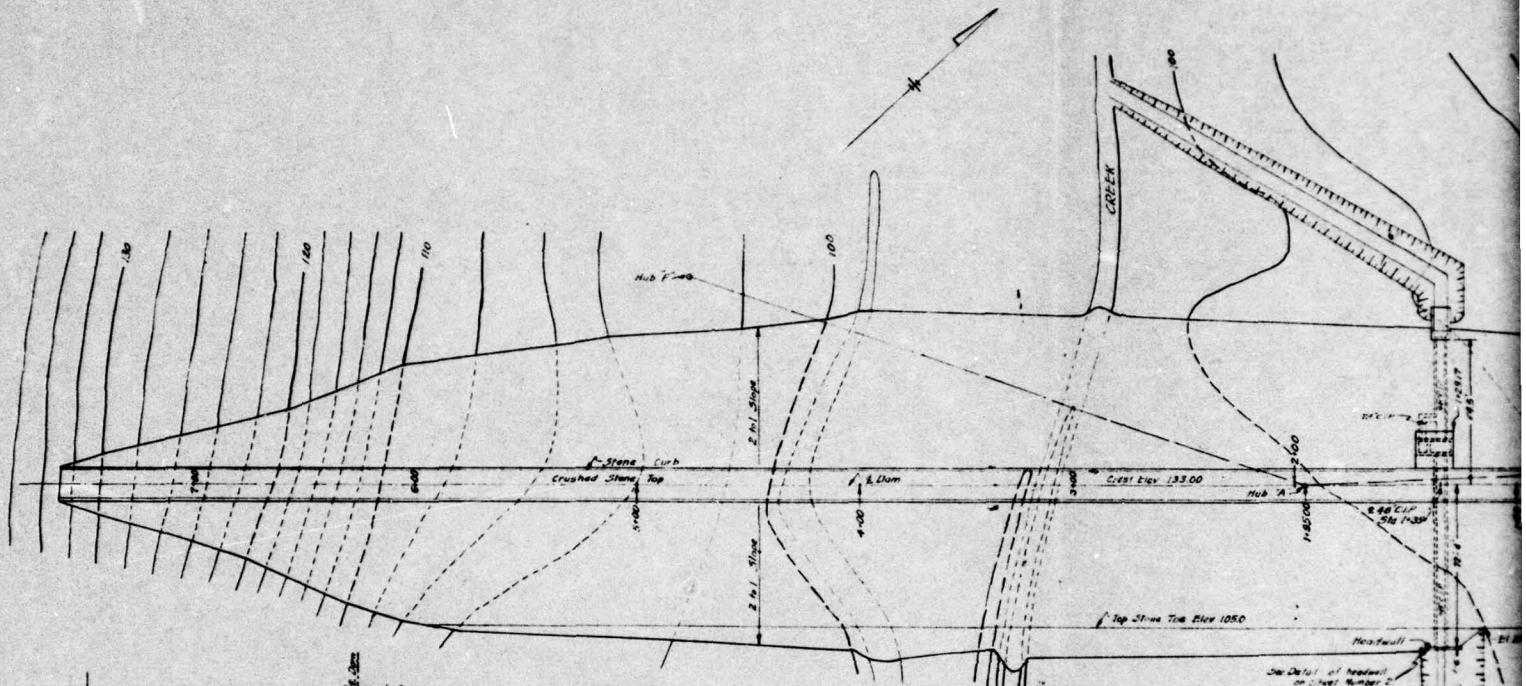
PLATES


DAM SITE
LOCATION PLAN
MEMORIAL LAKE DAM
PA. 603
PLATE I

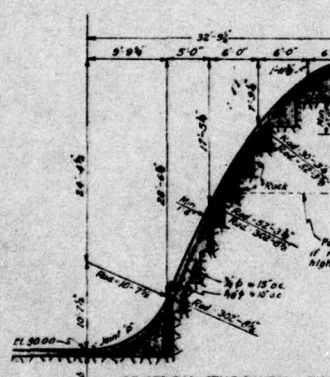

St Joseph Springs
ROAD
AMMO
BM 570
Indiantown Gap
MILITARY RESER
Gravel Pit
Run
HUNTING PARK
AVE
Marquette Lake
DRAINAGE AREA
7.9 SQ. MI.
BM 476
Gap
Gravel Pit
Indiantown
BOUNDARY
Trailer Par
ROAD
BM 433
Emmanuel Ch
BM 444
DAM SITE
State Memorial Lake
430
BM 513
Cem
BM 490
West Grass Field
485
INTERCHA
EAST HA
Indiantown
934
BM 432
Cem
Harper Tavern
489
East H
81
500
Zion Ch
VICINITY MAP
U.S.G.S. QUADRANGLE
INDIANTOWN GAP, PA.
MEMORIAL LAKE DAM
PA. 603
PLATE II



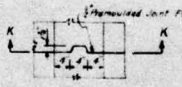
LONGITUDINAL SECTION THROUGH CENTERLINE OF DAM
Scale: 1"=30'



GENERAL PLAN DAM AND SPILLWAY
SCALE: 1"=30'

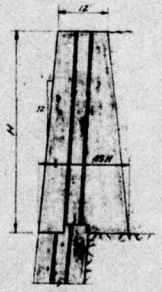


SECTION THROUGH OGEE
Scale 1"=10'

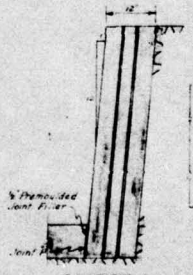


PLAN

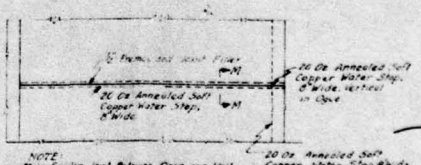
PLAN



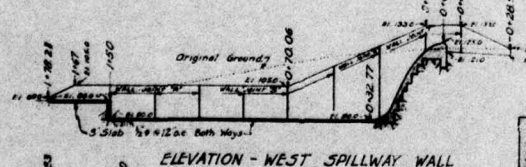
SECTION K-K
WALL JOINT 'R'
Scale ½"=1'



SECTION L-L
WALL JOINT 'S'
Scale ½"=1'

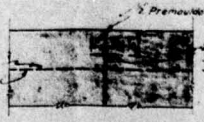


PLAN OF OGEE SHOWING JOINTS
Scale ½"=1'



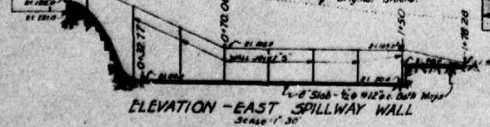
ELEVATION - WEST SPILLWAY WALL
Scale 1"=30'

JOINT "T"
Scale 3"=1'-0"

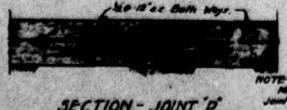


SECTION M-M
Scale ½"=1'-0"

NOTE: Make Similar Joint Between Ogee And Wall.

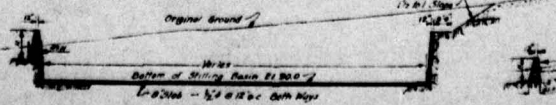


ELEVATION - EAST SPILLWAY WALL
Scale 1"=30'



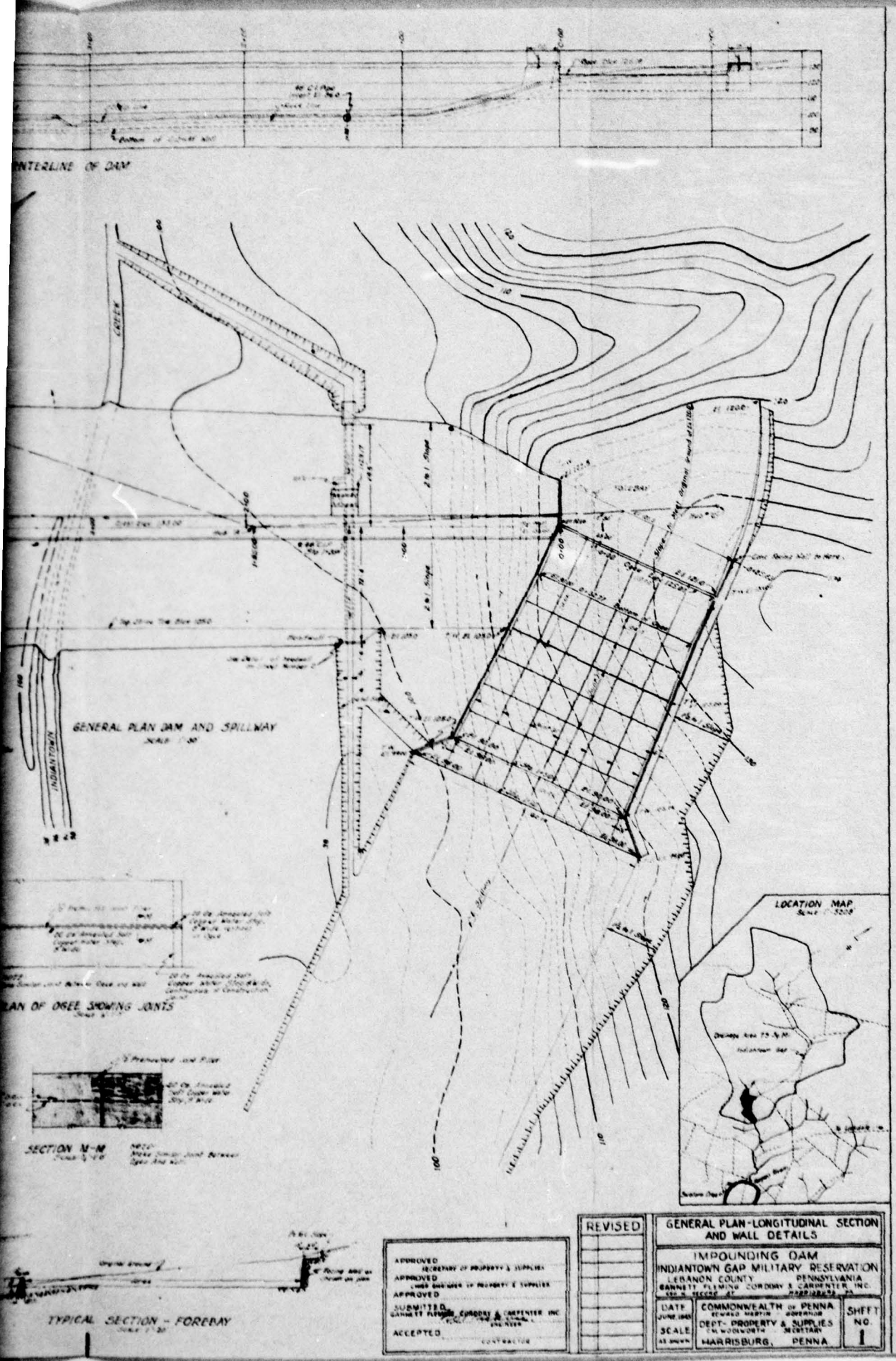
SECTION - JOINT 'P'
Scale 1"=1'-0"

NOTE: Make Similar Joint at Wall



TYPICAL SECTION - STILLING POOL
Scale 1"=20'

TYPICAL SECTION - FOREBAY
Scale 1"=20'



APPROVED
SECRETARY OF PROPERTY & SUPPLIES
APPROVED
UNDER SUPERVISION OF PROPERTY & SUPPLIES
APPROVED
SUBMITTED
GANNETT FLEMING CORDDRY & CARPENTER INC
ENGINEER
ACCEPTED
CONTRACTOR

REVISED

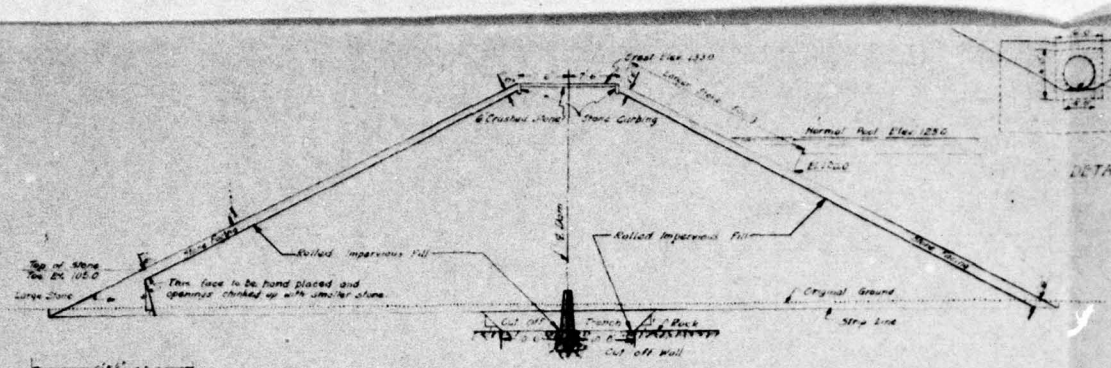
GENERAL PLAN-LONGITUDINAL SECTION AND WALL DETAILS

IMPOUNDING DAM
INDIANTOWN GAP MILITARY RESERVATION
LEBANON COUNTY PENNSYLVANIA
GANNETT FLEMING CORDDRY & CARPENTER, INC.

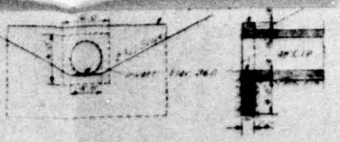
DATE	COMMONWEALTH OF PENNA	SHEET NO.
JUNE 1965	EDWARD MARTIN GOVERNOR	
SCALE AS SHOWN	DEPT. PROPERTY & SUPPLIES C.M. WOODWORTH SECRETARY	1
	HARRISBURG, PENNA	

2

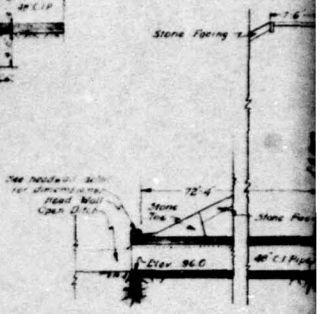
PA.603
PLATE III



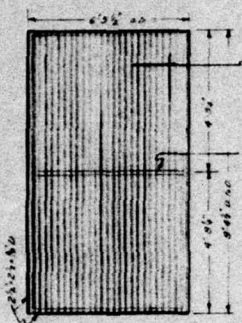
CROSS SECTION THROUGH DAM
SCALE 1"=10'



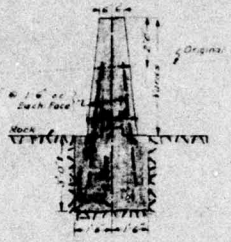
DETAIL OF HEADWALL



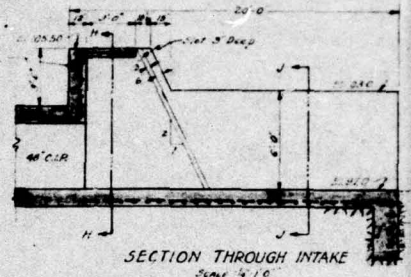
SECTION THR



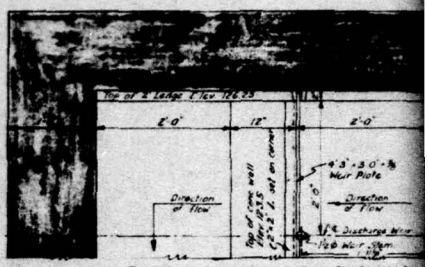
INTAKE BAR SCREEN
SCALE ⅜"=1'-0"



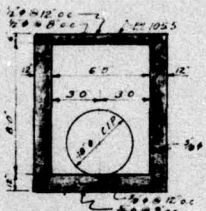
SECTION
CONCRETE CUT-OFF WALL
SCALE ⅛"=1'-0"



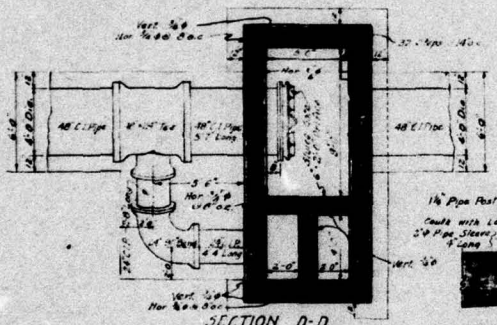
SECTION THROUGH INTAKE
SCALE ¼"=1'-0"



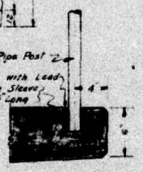
PLAN DISCHARGE WEIR SHOWING
WEIR SLIDE & PLATE
SCALE 1"=1'-0"



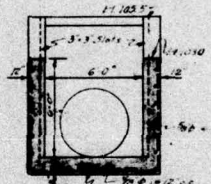
SECTION H-H
SCALE ¼"=1'-0"



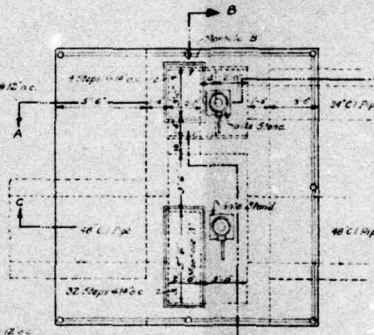
SECTION D-D
SCALE ⅜"=1'-0"



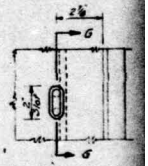
RAILING POST SOCKET
SCALE 1½"=1'-0"



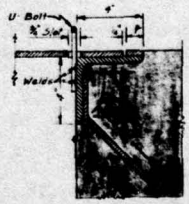
SECTION J-J
SCALE ¼"=1'-0"



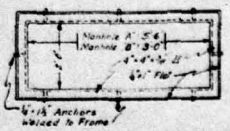
TOP PLAN OF CONTROL TOWER
SCALE ¼"=1'-0"



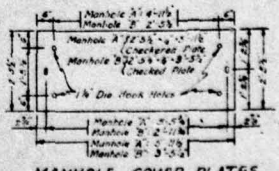
PLAN OF U-BOLT & SL
SCALE 3"=1'-0"



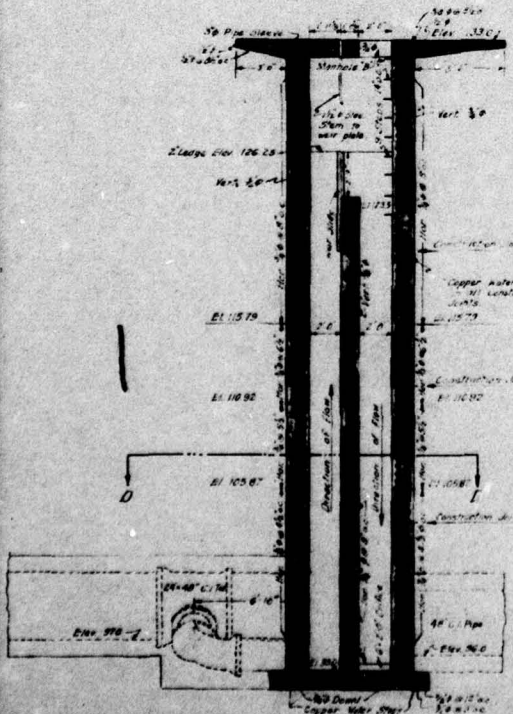
DETAIL THROUGH ANGLE
FRAME
SCALE 3"=1'-0"



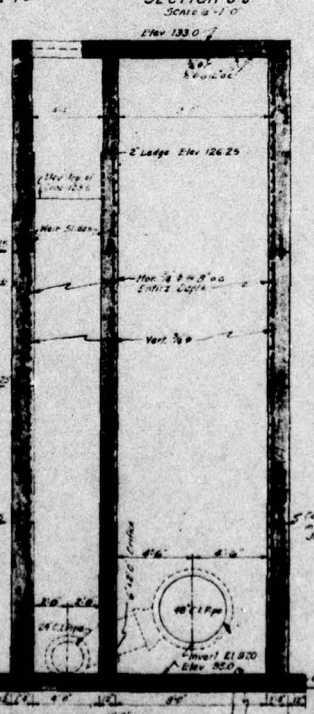
PLAN OF MANHOLE FRAMES
NOT TO SCALE



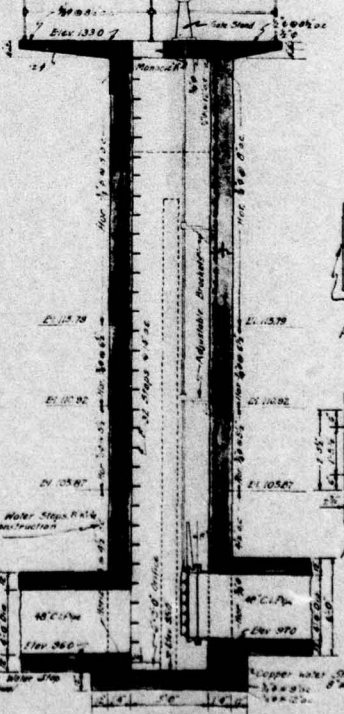
MANHOLE COVER PLATES
Not To Scale



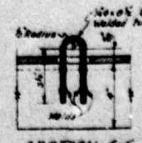
SECTION A-A
Scale ¼"=1'-0"



SECTION B-B
Scale ¼"=1'-0"

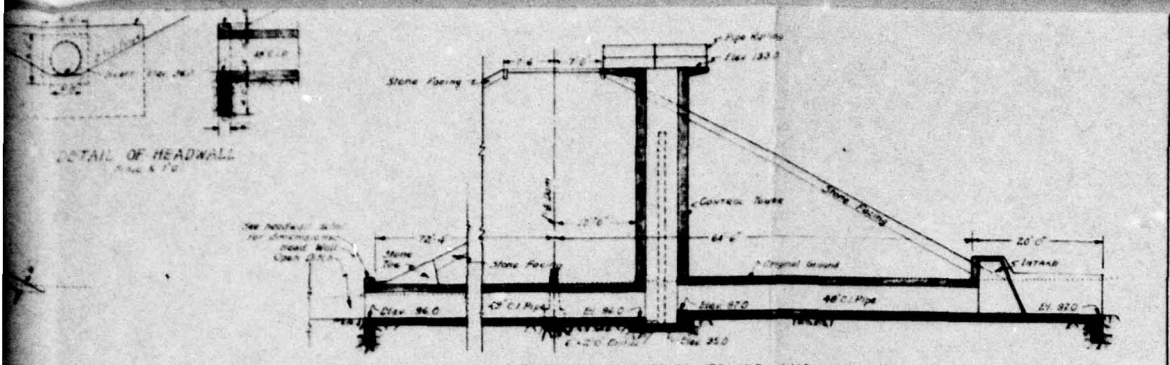


SECTION C-C
Scale ¼"=1'-0"



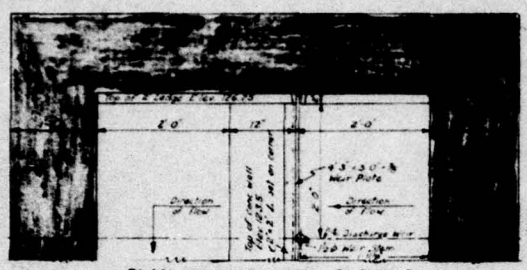
SECTION 6-6
Not To Scale

APPROVED
APPROVED
APPROVED
SUBMITTED
ACCEPTED

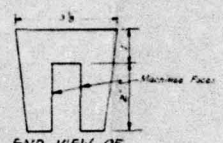


DETAIL OF HEADWALL

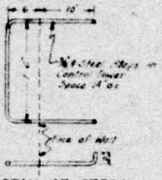
SECTION THROUGH CONTROL TOWER AND INTAKE
Scale 1"=10'



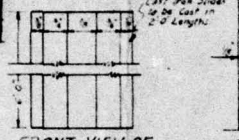
PLAN DISCHARGE WEIR SHOWING WEIR SLIDE & PLATE
Scale 1"=10'



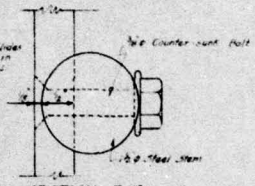
END VIEW OF WEIR SLIDE
Scale 6"=1'0"



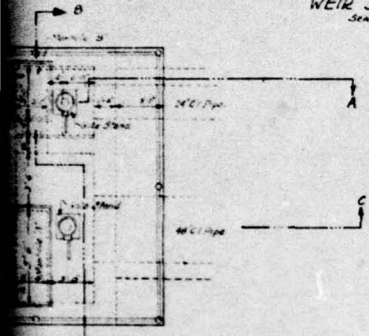
DETAIL OF STEPS
Scale 1"=10'



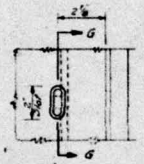
FRONT VIEW OF WEIR SLIDE
Scale 6"=1'0"



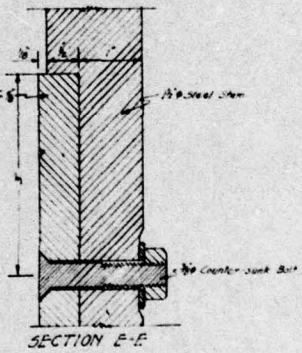
SECTION F-F
Full Scale



F CONTROL TOWER

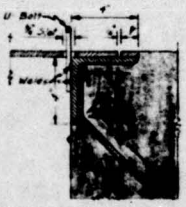


PLAN OF U-BOLT & SLOT
Scale 3"=1'0"

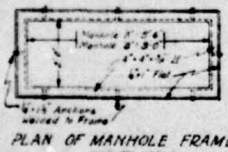


SECTION E-E
Full Scale

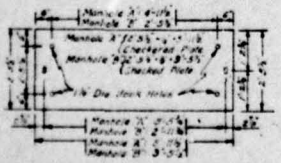
TOP VIEW OF WEIR PLATE
Scale 1"=1'0"



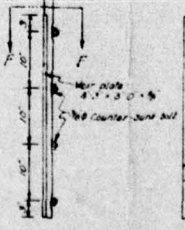
DETAIL THROUGH ANGLE FRAME
Scale 3"=1'0"



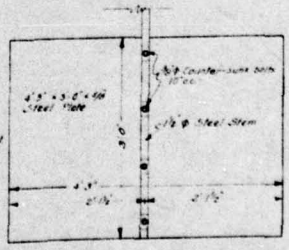
PLAN OF MANHOLE FRAMES
NOT TO SCALE



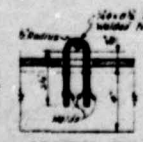
MANHOLE COVER PLATES
Not To Scale.



ELEV. OF WEIR & STEM
Scale 1"=1'0"



FRONT VIEW OF WEIR PLATE
Scale 1"=1'0"



SECTION G-G
Not To Scale

APPROVED
SECRETARY OF PROPERTY & SUPPLIES

APPROVED
CHIEF ENGINEER OF PROPERTY & SUPPLIES

APPROVED

SUBMITTED
GANNETT FLEMING CORDRY & CARPENTER INC

ACCEPTED
CONTRACTOR

REVISED

CROSS SECTIONS AND DETAILS

IMPOUNDING DAM
INDIANTOWN GAP MILITARY RESERVATION
LEBANON COUNTY PENNSYLVANIA
GANNETT FLEMING CORDRY & CARPENTER, INC.
HARRISBURG, PA.

DATE	COMMONWEALTH OF PENNA. EDWARD MARTIN GOVERNOR	SHEET NO.
JUNE 1943	DEPT. - PROPERTY & SUPPLIES C.M. WOOLWORTH - SECRETARY	2
SCALE AS SHOWN	HARRISBURG, PENNA.	

2

PA. 603
PLATE IV